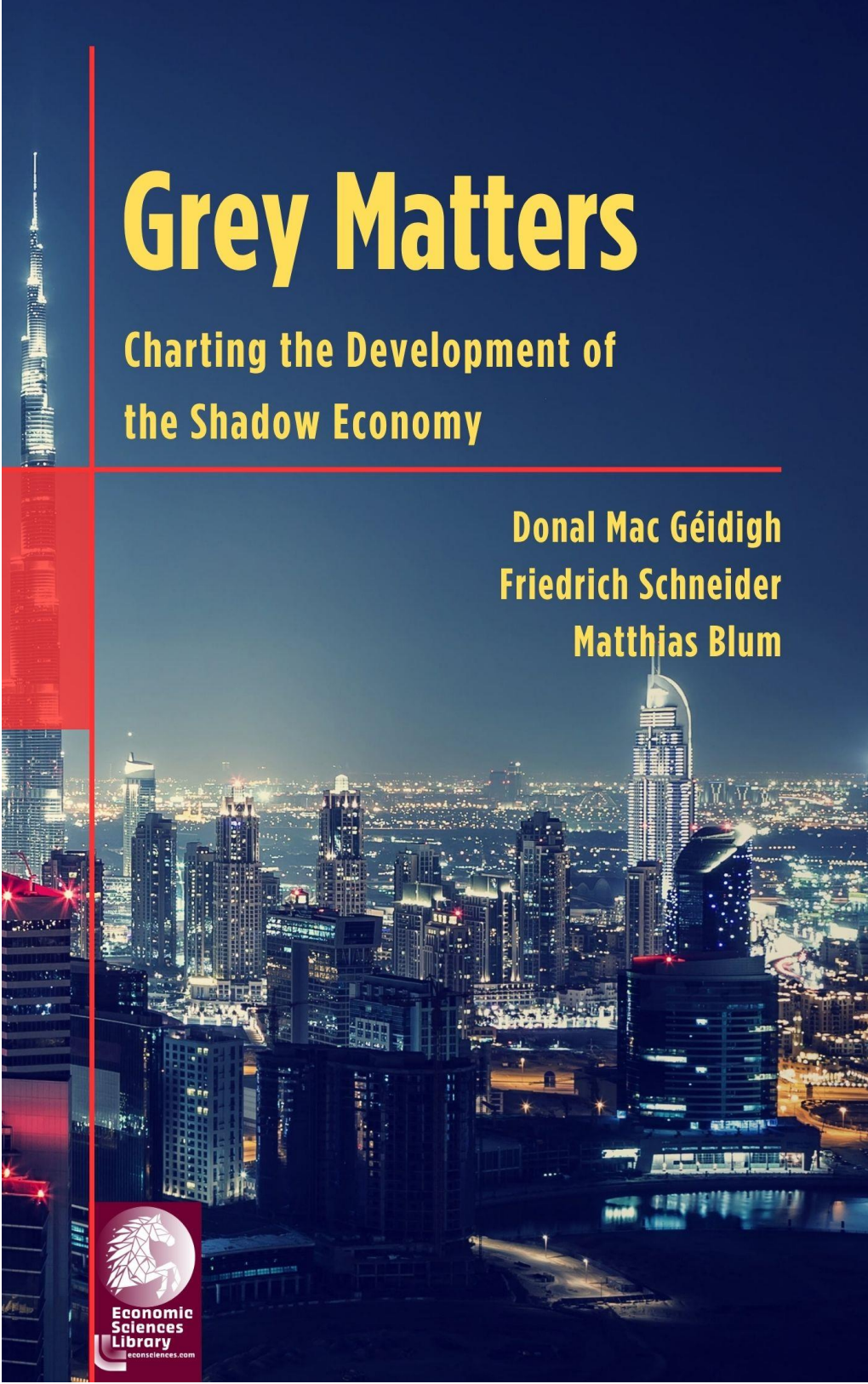
Grey Matters

Charting the Development of the Shadow Economy

Donal Mac Géidigh
Friedrich Schneider
Matthias Blum



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Grey Matters: Charting the Development of the Shadow Economy
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Preface

The shadow economy has long been an area of research for policymakers. The determinants of underground activity of late have been identified as high tax burdens and increased regulation, but has this relationship always existed? This seminal work examines the shadow economy in Norway, Sweden, the United Kingdom and the United States over the past 145 (from 1870 to 2015) years using the Currency Demand Approach and finds that the underground economy is stabilising. To our knowledge this is the first attempt to estimate the size and development of the shadow economy over such a long period and due to this we get some new insights. Our results clearly show that the shadow economy in earlier times was considerably higher than in the last 50 years. This book also analyses whether a plateau has been reached and questions what efforts could be made to further reduce this informal economy.

Géidigh, Schneider & Blum
November 1, 2025

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1. Introduction

The purpose of this study is to develop estimates of the size of the shadow economy in a panel of countries from 1870 to 2015. The countries under examination are Norway, Sweden, the United Kingdom, and the United States. When developed these estimates can be added to official GDP to provide an alternative dataset of GDP figures. There does not exist so far any scientific research or research papers which try to estimate the size and development of the shadow economy over the period 1870-2015 from Norway, Sweden, the United Kingdom and the United States. Hence, our paper is a first approach to estimate the size of a shadow economy of these four countries over such a long period. It hopefully has a lot of valuable insights.

Researchers, economists, and policymakers alike could benefit from this study in numerous ways: First and foremost, shadow activity is unrecorded activity, unrecorded activity is untaxed activity meaning that state revenue is below its potential level. Secondly, the shadow economy represents a source of income and employment for individuals whose output is not included in national income account statistics.

Revised GDP figures (including a shadow economy component) would provide a more accurate picture of the wealth of these four economies and their inhabitants over the last century and a half. Thirdly, Central Banks and other monetary policymakers often take their cue from economic indicators such as output, unemployment and inflation. If these indicators are inaccurate due to the presence of a large shadow economy, inappropriate policies may be adopted in response. Inaccurate macroeconomic indicators such as overestimated unemployment could lead to the implementation of expensive, inefficient social welfare programmes aimed at reducing unemployment, meaning that the plight of those who are marginalised in other areas of society may worsen.

The following section discusses developments in the world economy and political landscape over the past 150 years while also evaluating the existing literature concerning the shadow economy. Section 3 gives an overview of the methodology used to estimate the size of the shadow economy, in this case the Currency Demand Approach. Section 4 presents the empirical results and estimates of the shadow economy. Section 5 concludes the study with a view to further research in this area.

2. Literature Review

"There cannot be any question that the underground economy is a real phenomenon with important implications that deserve attention and study"
Vito Tanzi,(1999: 338)

2.1. General Remarks

An important component of measuring the size of the shadow economy is the development of monetary aggregates, namely M0 - currency in circulation, and its relationship with other measures of the money supply; M1, M2, M3 and occasionally M4. While section 3 provides a more in-depth examination of the methodology it is important to briefly lay out the intuition behind the method of measuring the shadow economy in this study: The Currency Demand Approach.2

Cash is assumed to be the fuel in the engine of shadow economic activity (Issachson & Strom, 1986). Clandestine transactions are assumed to be carried out in cash to avoid leaving a paper trail for authorities (Tanzi, 1983). Thus, an increase in the size of the shadow economy will mean that currency in circulation among the public will increase. Alanon & Gómez-Antonio (2005), Dell'Anno *et al.* (2007), Buehn (2012), Schneider (1986) and Schneider *et al.* (2010) have all concluded that the relationship between the amount of

currency held by the public and the shadow economy is positive and statistically significant. Individuals obtain this extra currency by withdrawing money from their bank accounts, leading to an increase in Mo and a decrease in M1 or M2 (depending on which currency ratio is used). Of course there could be conventional factors and events that might lead to changes in the currency ratio, such as rising interest rates on deposit accounts increasing the opportunity cost of holding currency, development of income, payment habits etc. These factors must be controlled for, as well as controlling for developments in the tax burden and government regulation which are assumed to be major factors incentivising individuals to work in the shadow economy (Feld & Schneider, 2010). The excess increase in currency holdings (the amount unexplained by the explanatory variables) is then attributed to the shadow economy.

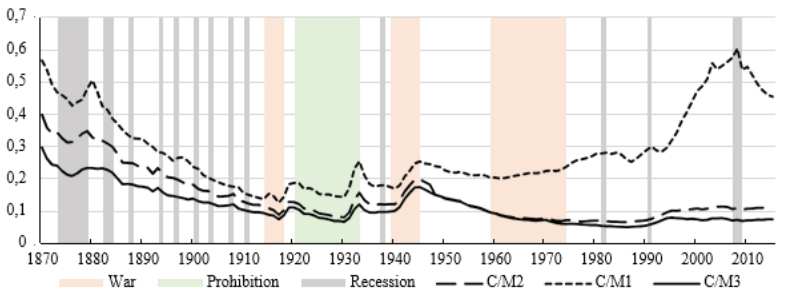


Figure 1. *United States Currency Ratio 1870-2015*

Figure 2 and Figure 3 provide a graphic illustration of the currency ratio in the two Anglophone countries in the panel. The ratio of Currency in Circulation to M1, M2 and M3 has fluctuated widely over time, with the C/M1 ratio declining from 0.6 to .015 in 1913, before peaking again in 2008. Recessions (lasting more than 12 months) are indicated in grey on the chart and appear to be associated with an increase in the C/M1 ratio, especially during the Great Depression. Prohibition is associated with a decrese in the the currency ratio. Both World War I and II as well as the Vietnam War have been associated with an increase in the ratio of C/M1.

The ratio of C/M2 and C/M3 seem to move in lockstep until the turn of the millennium after which the relationship disappeared.

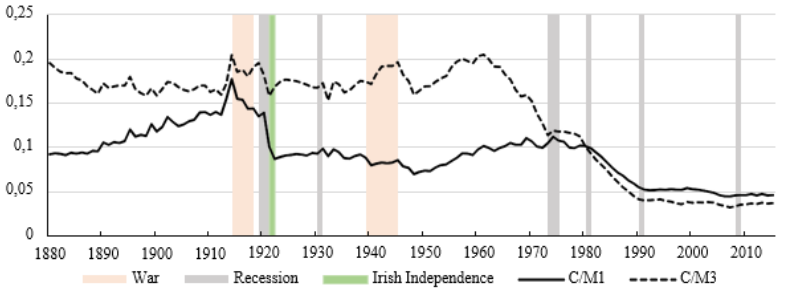


Figure 3. *United Kingdom Currency Ratio 1880-2015*

Figure 3 Shows how the currency ratio in the UK reacted to major events. World War I and II brought about an increase in the ratio of C/M1 indicating that people were holding more currency, potentially for use in the underground economy. The recession post World War I appears to have brought about a decrease in the currency ratio.

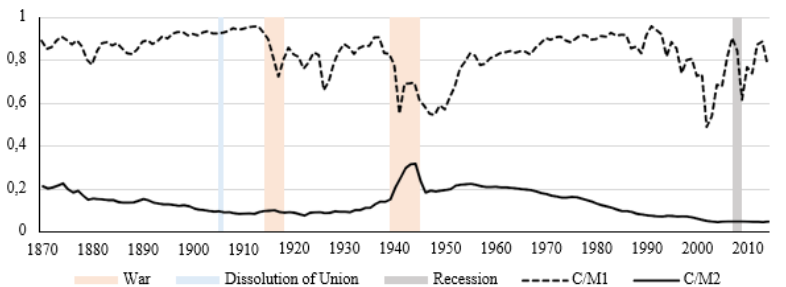


Figure 4. *Norwegian Currency Ratio 1870-2015*

Norway is unique in this study in that it is the only country that shows a large decrease in the currency ratio during both World War I and II (however it subsequently increased). The Global Financial Crisis of 2008 led to a large decrease in the ratio of C/M1 in Norway.

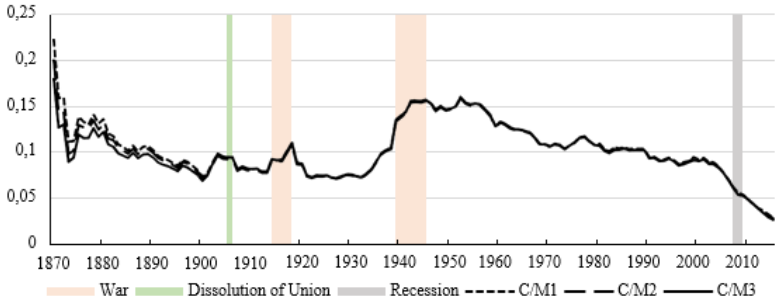


Figure 5. *Swedish Currency Ratio 1870-2015*

Figure 5 shows the ratios of C/M1 C/M2, and C/M3 moving in close formation in Sweden. The peaceful dissolution of the union between Sweden and Norway does not appear to have a had a major impact on the currency ratio however the outbreak of both World Wars led to large increases in the ratio of C/M1 and C/M2 in Sweden.

While many papers have empirically examined the contemporary shadow economy, few have cast an eye back as far the first half of the 20th century and to this author's knowledge none have examined the late 19th century. The earliest estimates of the size of the shadow economy are those of Tanzi (1983) who approximates the size of the underground economy in the US for the years 1930-1980. However, these estimates have come under criticism in their own right from Hassan & Scheider (2016) citing the flawed assumption on Tanzi's part that the velocity of money is the same in both the legal and illegal economy3, leading to inaccurate estimates.

2.2. Historical context

Charting the development of the clandestine economy over such a long period as the one in this study brings its own challenges. A century of change and innovation, in terms of financial innovation altered the where and the way in which individuals did business. Banking, and in particular, holding an account, which was once considered the preserve of the elite in the early 19th century, is now commonplace (World Bank, 2009). The cheque book which facilitated transactions

and reduced the need to carry cash made way for debit card and other forms of plastic money. Indeed, the physical act of visiting a bank branch is becoming less common as more and more financial services move online. From the comfort of one's own home money can be sent to or spent in any corner of the world, further reducing the need for individuals to carry out transactions in currency. The Classic and Interwar Gold Standards were considered the Good Housekeeping Seal of Approval (Eichengreen, 1992), and countries which adhered to the rules benefitted from lower interest rates (ibid.). The idea of a currency not pegged to bullion was unthinkable and caused must discontent among them public, causing panics and almost causing a run on the Bank of England who used interest rates and borrowed unashamedly to stay afloat.

However, changes were not only confined to the financial sector. Each of the four countries in this panel have experienced exogenous and endogenous shocks4; inflationary, technological and political. Some of these shocks were shared, for example each of the four countries were affected by World War Two, Norway with its government in exile was occupied by Nazi forces, Sweden maintained its neutrality but made concessions to both sides. The United Kingdom was a major belligerent in the war as was the United States who joined in the later years. These wars had major effects on employment and spending. The introduction of the rationing of goods was meant to limit shortages and ensure the wartime population had sufficient nutrition. However, this strict rationing led to inevitable increase in black market activity (Thomas, 2003). The bloody tatonnement of the trenches of the Somme and the dogged victory on the bloodstained beaches of Normandy brought about the need for increased taxes and import tariffs to finance the war effort. This increase in import tariffs gave rise to smuggling and tax evasion (Hilson, 2008). During this period global economies flirted with different schools of economic thought, but by the end of World War II (in our panel of countries at least) the ballot box of democracy had safely eradicated the political ideologies that threatened to emerge from the barrel of the Marxist gun.

Other shocks were felt in isolation, the peaceful dissolution of the Union between Sweden and Norway in 1905 would not have sent shockwaves across the Atlantic (Hilson, 2008) but would have important economic ramifications for the countries involved in terms of autonomous formulation of monetary policy and international trade (Klovland, 1983).

In the United States the nationwide constitutional ban on the production, importation and sale of alcoholic beverages during the period 1920-1933 became the largest source of illegal income and jobs (Orkent, 2010). Before the advent of modern income tax, customs duties and liquor taxation accounted for up to 75% of federal government revenue. (Boudreaux, 2008). Prohibition, is a prime example of a once legal transaction that became illegal overnight. The unintentional effect of prohibition was that it allowed organised crime to flourish, particularly the activities of the American Mafia, (Woodiwiss, 1987) this in turn increased the amount of shadow economic activity (ibid.). Popular and expert opinion today and at the time consider the policy of prohibition a failed experiment (Vitaliano, 2015). Prohibition led to thousands of job losses in the brewing, distilling, barrel making, transportation and restaurant businesses (Orkent, 2010). The sums of money being exchanged during this dry era meant that corruption and bribe-taking was rampant in the federal Bureau of Prohibition. The godfather of bootlegging illegal liquor, Al Capone, is estimated to have made $60 million per year from the sale of illegal beer alone, (Kobler, 1971) as well as running over 10,000 speakeasies (ibid.). This $60m figure represents a loss to the US exchequer in the form of taxes since the money was generated in the shadow economy.

Central Banks govern many issues such as monetary policy and the minting of notes and coins as well as the very definition of monetary aggregates. NorgesBank, Riksbank, and the Bank of England were very much established by the time the US Federal Reserve system of central banking was established in 1913. Caution must be taken when interpreting the definition of currency in circulation in the United States

as a result, since many different institutions were printing and minting notes and coins. This is discussed further in Section 3.

2.3. The Demand for Currency

The earliest known work on the demand for currency to this author's knowledge dates from 1958 when Philip Cagan estimated the public's demand for currency relative to the total money supply. Cagan's work on the demand for currency is a cornerstone of this project since it helps distinguish "official" as opposed to "illegal" increases in currency in circulation. His seminal work in 1958 provides the famous currency demand function upon which many papers have been based since

$$Co=\alpha\ (1+\theta)\alpha\ Yo\ \exp(-\gamma i)$$

where Co is observed cash and Θ represents the variable that incentivises individuals to engage in underground activities, believed to be the tax burden or the intensity of government regulation. This variable is the key variable in the CDA because an increase in Θ is expected to have a positive impact on currency demand, hence individuals hold more cash for their informal transactions. Yo is the official GDP which represents the level of transactions in an economy. Other measures of the Yo can be income per Capita or consumption per Capita. i is the interest rate or inflation rate representing the opportunity cost of holding cash. Finally, the A, α, β, and γ are the parameters. This equation lends itself to estimating the size of the shadow economy but this is discussed further in Section 3.

Deposits and withdrawals in currency are of interest to monetary policymakers. In particular because they influence bank reserves and since they are not subject to direct control by monetary authorities, they must be factored into open market operations of the central bank when planning monetary measures. Cagan (1958) finds that the currency ratio in the US varied considerably. It was greater than 30 percent in 1879 when gold convertibility was restored and declined to

just over 7 percent by 1930. While Cagan cannot immediately explain the reason for this downward trend in the ratio of currency supply he cites factors such as the spread of banking in the US in the years preceding the Great War and an increase in the availability of checking accounts. Cagan states that prior to the introduction of deposit insurance in the 1930s, economic conditions could adversely affect deposits which were seen as less safe than currency. Banks could delay or default on deposit payments if the bank became insolvent. Cagan then goes on to say that "the use of currency to conceal taxable transactions was probably higher during and after the war because income tax rates were raised considerably early in World War II". Cagan estimates unreported income of $15bn in 1945, 60-70 per cent of which can be attributed to the wartime increases in income tax rates.

2.4. Existing Findings

Tanzi (1983) highlights the reasons for studying the underground economy, citing the distortion of official macroeconomic variables and the resulting distorted policies that are set in response. By developing a demand-for-currency equation and inferring the change in the tax level on that demand Tanzi estimates that the size of the shadow economy ranged from 0.41 per cent of GNP in 1936 to 4.49 per cent in 1980. He surmises that the demand for currency is a function of the four following variables: Income per capita, the interest rate, the tax burden and the ratio of wages and salaries in National Income. The significance of these variables is described in greater detail in later sections. His findings indicate a shadow economy of between 0.6-6 percent of GDP in the United States between 1929 and 1980, or in monetary terms, between $0.55bn and $159.31bn during the same time period.

Tanzi (1983) presents disturbing findings in the form of an increasing shadow economy, especially towards the end of the period under observation, he surmises that "this trend was probably influenced by the substantial increase in marginal tax rates over the period 1975-8". This study will borrow from

the work of Tanzi in terms of the basic regression equation, however several variables will be added to it to make the model more relevant for today's economy, factors such as cheque payments, debit cards etc. However, Tanzi's work, like most works on the shadow economy make several assumptions, the main one being that shadow economic activity is driven by changes is marginal tax rates. It is with this point that Bhattacharyya (1990) takes umbrage. He criticises Tanzi's estimates since Tanzi is in essence testing theories of tax evasion conditional on the variables under examination.

Kirchgaessner & Schneider (1986) used the currency demand approach, too. A common trend across studies of Schneider is the importance of the tax burden in driving underground activity (Schneider 1986, 1994a,b, 1997, 1998a,b, 2000, 2003b, 2005, 2008 2010). This is due to the fact that taxes affect the labour-leisure trade-off and can also stimulate labour supply in the shadow economy. He reiterates that the overall tax burden is a major concern for economists: " Since this difference depends broadly on the social security burden/payments and the overall tax burden, they are key features of the existence and the increase of the shadow economy. The validity of these claims have been reinforced by several other authors such as Tanzi (1980, 1983); Thomas (1992); Lippert & Walker (1997); Johnson, Kaufmann, & Zoido-Lobatón (1998a, 1998b); Tanzi (1999); Giles (1999a); Mummert & Schneider (2001); Giles & Tedds (2002) and Dell'Anno (2003).

The Norwegian and Swedish shadow economies are of interest to researchers due to the high tax burden in these Nordic countries. Klovland (1984) measures the underground economies in Sweden and Norway and finds a statistically significant relationship between marginal tax rates and shadow economic activity in Sweden but not in Norway. Schneider (1986) estimates the shadow economies in the Nordic countries using the currency demand approach and finds that the size of the Norwegian underground sector was around 3 percent of GDP in 1960 but grew steadily to around 10 percent by the mid-1980s. the Swedish underground sector

ballooned from 1.5 percent of GDP in 1960 to 12 percent of GDP by 1985. More recent work by Schneider (2005) has placed the Swedish shadow economy at around 19 percent of GDP at the turn of the millennium while the results for Norway were similar. According to the same study the United Kingdom and the United States have shadow economies at the smaller end of the scale, measuring 12.5 and 8.7 percent of GDP respectively in the year 2000. In a working paper commissioned by the Riksbank, Guibourg & Segendorf (2007) estimate that the Swedish Shadow economy has grown from 3.8 to 6.5 percent of GDP between 1990 and 2004. This highlights the potential differences in estimates of the shadow economy occurring due to different model specifications. Schneider (2012) as well as a report published by the Norwagian Association of Lawyers (2014) find that the Norwegian underground sector is one of the largest in the group of OECD countries, with estimates of 18 and 14 percent of GDP respectively.

3. Methodology

"The black market was a way of getting around government controls. It was a way of enabling the free market to work. It was a way of opening up, enabling people"
Milton Friedman, (1974)

3.1. Currency demand method

While the intuition behind the estimation approach used in this study, the Currency Demand Approach; is described in depth, we will not discuss other approaches due to a space reason.5

While individuals may be reluctant to admit their involvement there are other ways to examine the size of the shadow economy, their supposed untraceable transactions leave a stamp on the monetary aggregates of the country. This indirect method of estimating the size of the underground sector is called the Currency Demand Approach. The main assumption of this approach is that cash is the fuel in the engine of the underground economy. Transactions take place in currency since it is doesn't leave a paper trail for authorities to follow, keeping the activities in the shadows. Isachson & Strom (1985), find that over 80 percent of shadow economic transactions take place in cash. If we could isolate the amount of cash used for illicit activities, we could infer the size of the informal sector. The premise for this approach relies on an

examination of the ratio between Mo (currency in circulation) and M1 (or M2), currency in circulation and transaction deposits at depository institutions, (M1 + "near money").

An increase in shadow economic activity would imply that individuals are holding more cash to pay for this increase in activity. They withdraw money from their deposit accounts as a result. M1 falls and Mo increases. However, there are other factors which could cause an increase in the amount of money in circulation: central banks printing more money would lead to a natural increase in Mo, falling interest rates might disincentivise individuals from lodging money in their bank accounts.

Similarly, rising interest rates may incentivise individuals to lodge money since they can achieve a return on it. These factors must be taken into account when estimating the demand for currency. In essence we are isolating the increase in Mo that can be attributed to the shadow economy. To estimate this "excess" demand for cash, an econometrically estimated demand for currency equation is developed over time. This is known as the Currency Demand Approach which was pioneered by Cagan in 1958, subsequently by Peter Gutmann in 1977 and by Tanzi (1983).

The dependent variable can be taken as either the ratio of currency to demand deposits or the ratio of currency to M2. After the Great Depression in the US, banks payed only a negligible sum of interest on demand deposits (Tanzi, 1980) so individuals may not have held as much money in demand deposits as the opportunity cost was low. During this period of declining spending, time deposits may have replaced demand deposit accounts as the interest payable was higher. This would lead to a natural decrease in M1 which could not be attributed to the shadow economy. The favoured dependent variable of Schneider and also Kirchgaessner is Mo/M1, or alternatively currency in circulation outside the banking sector normalised by the GDP deflator. The following section sets out the explanatory variables used in the econometric equations and a brief description justifying their inclusion, citing works where they have been employed

previously and hypothesising their relationship with the currency ratio.

3.2. Variables used in estimating the demand for currency

Tax Burden

One of the key assumptions underpinning the Currency Demand approach to modelling the Shadow Economy is that taxes are the main driver of underground activity. Many empirical studies (Tanzi, 1983; Schneider 1986, 1994, 2005; Fleming 2000; Schneider and Enste, 2000; Hassan and Schneider 2016, Bitzenis *et al.*, 2016) have confirmed the statistically significant, positive relationship between the tax burden and the underground economy. Loayza (1999) concludes from his examination of a panel of Latin American countries that "informal economies arise when governments impose excessive taxes and regulations that they are unable to enforce". Taxes are of interest, too, because they influence the labour-leisure trade-off and can stimulate participation in the informal economy.

The intuition is that an increase in taxes reduces net (after tax) income and as such it may be more lucrative for individuals to operate in the shadow economy as they may not have to pay taxes at all. The Tax Burden is defined as the revenues collected from taxes on income and profits, social security contributions, taxes levied on goods and services, payroll taxes, taxes on the ownership and transfer of property, and other taxes. An increase in these taxes make goods and services more expensive in the formal market and can incentivise individuals to operate in the informal sector (Loayza 1996; Schneider 2005). In the econometric estimations 1970-2015 the tax burden is represented by the share of total tax burden to GDP as per the OECD definition. In the 1913-1970 period the average and top marginal tax rates are employed. Due to lack of data availability the 1870-1913 period uses the percentage of tax revenue in GDP, which is similar to the tax burden.

Hypothesis 1: The greater the tax burden, the greater the demand for cash payments, ceteris paribus.

Real GDP

Real GDP is a macroeconomic measure of the value of economic output (all goods and services) in a country in a given year, adjusted for price changes (i.e. inflation or deflation).

Hypothesis 2: The greater the growth of the official economy, the smaller the size of the shadow economy, ceteris paribus.

Interest Rate

Interest rates have long been used by policymakers to influence the level of investment and spending in an economy especially during the Gold Standard in attempts to control capital flows. A high (low) interest rate on deposit accounts increases (decreases) the opportunity cost of holding currency.

Hypothesis 3: the higher the interest rate the lower the demand for cash payments, and thus the shadow economy, ceteris paribus.

Unemployment Rate

Hypothesis 4: The greater the level of unemployment in a country, the greater the demand for cash payments, ceteris paribus.

Self-employment rate

Self-employed individuals are often faced with bureaucracy and legislation when setting up business. Schneider and Enste (2002) and Hassan and Schneider (2016) cite this bureaucracy as a driver of underground activity.

Hypothesis 5: The greater the number of self-employed individuals in a country, the greater the demand for cash payments, ceteris paribus.

Crime

Since a large component of the shadow economy is illegal activity, in addition to the traditional explanatory variables we introduce a criminal element, in an attempt to separate the illegal cash- settled economy from underground production.

Hypothesis 6: An increase in crime (fraud) leads to an increase in the demand for cash payments, ceteris paribus.

Wages and Salaries in National Income

Hypothesis 7: An increase in wages and salaries in National Income leads to an increase in the demand for cash payments, ceteris paribus.

Social Welfare spending as a percentage of Total Government Spending

Hypothesis 8: The higher government spending on social welfare the larger the demand for cash, ceteris paribus

Civic employment

Hypothesis 9: An increase in public sector employment leads to an increase in the shadow economy, ceteris paribus.

3.3. Additional remark

The type of model run varies by period. Due to data limitations the model run for the 1870-1913 period is an OLS model similar to the one employed by Tanzi (1980) where estimates have been corrected for serial autocorrelation. The 1913-1970 and 1970-2015 periods employ a Vector Error Correction model as used by Macias & Cazzavillan (2009) and Hassan & Schneider (2016). This method is superior to

standard OLS since it allows us to capture both long and short-run effects. VEC Model estimates will be more efficient (as a VECM has a restricted VAR representation) (Christofferson & Diebold, 1998). This is examined in more detail in section 4.

4. Emprical results

"The income tax created more criminals than any other single act of government."
Barry Goldwater, Republican Party Nominee for President of the US, 1964.

4.1. From civil war to the Somme: 1897-1913

The vast array of data available for contemporary shadow economic estimations is not available for this time period so the regression equations are rather rudimentary. The skeleton of the regression equations is taken from Tanzi (1980) who uses only 4 variables to determine the long run behaviour on the currency ratio (C/M2): Income per capita, the interest rate, the tax burden and the share of wages and salaries in National Income.

The model used to estimate the shadow economy in the UK is as follows:

$$C/M2 = \alpha 0 + \alpha 1(Y/capitat) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(WELFAREt) + \varepsilon t \quad (1)$$

The independent variables are real Income per Capita (Y/Capita), the rate of interest paid on time deposits (R), the amount of government spending on welfare (WELFARE) and the tax variable (1+T). Income tax as we know it today was

introduced in the UK in the years preceding World War 1, finding a consistent variable to capture the effect of taxation prior to 1913 is difficult so we have used the amount of tax revenue collected each year as a percentage of GNP to act as the tax burden. Having become the hegemonic power of the 19th Century through its supremacy in industry and railroads the United Kingdom was a frontrunner in innovation, with a keen interest in the welfare of its citizens. A reform which had a major impact on the population was the Public Health Act of 1872, which led to the establishment of health authorities around England and provided funding for housing, water and disease prevention, financed through local government taxes. The inclusion of this WELFARE variable has its roots in the findings of Schneider (2000), who finds that social security contributions have a positive effect on the size of the shadow economy. Since these reforms were achieved through an increase in the tax rate, this is hypothesised to lead to more demand for currency.

The coefficients of the regression as well as other information are displayed in Table 2 alongside the regression results for Norway, Sweden, and the United States. This was done to aid cross-country comparisons.

For Norway and Sweden, the following econometric equation from Tanzi (1980) has been employed:

$$C/M2 = \alpha 0 + \alpha 1(Y/capitat) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(WAGESt) + \varepsilon t \quad (2)$$

The econometric equation used for the United States is the same as that used for Norway and Sweden with the inclusion of total expenditure as an additional explanatory variable to put further pressure on the demand for currency. The tax burden has been estimated in the same way as for the United Kingdom, total tax revenue as a percentage of GNP. The equation reads as follows:

$$C/M2 = \alpha 0 + \alpha 1(Y/capitat) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(WAGESt) + \alpha 5\,(TOTEXP) + \varepsilon t \quad (3)$$

Estimation/Regression Results

Total Expenditure is expected to have a negative effect on the demand for currency ratio, since an increase in government spending may appease individuals who feel overburdened by the tax level since they may feel that they are receiving better value for money from their tax payments. The results from the regression equation are found in table 1 below. The results are highly statistically significant with a high R2 implying that most of the variation in ln C/M2 can be explained by the estimated equations.

Income per capita is strongly, positively, statistically significant for the UK and Norway, however it is negative for Sweden and the US, implying that shadow economic activity moves in lockstep with economic development in the UK and Norway while in Sweden and the US the opposite is true. The interest rate has a negative effect on the currency ratio in the UK, Norway and the US which is intuitive since if the interest rate rises, the amount of currency in circulation should fall due to an increase in the opportunity cost of holding money. At odds with the results of Tanzi (1980) there is no statistically significant relationship between wages and salaries in national income and the currency ratio. The tax burden is the only variable which has a consistent sign across the panel of countries and is significant at the 1 per cent level. This implies that an increase in the tax burden leads to an increase in the currency ratio. To test for autocorrelation among the residuals the Durbin-Watson statistic was calculated. The results are greater than 1.71 for the panel of countries, indicating that autocorrelation among residuals is not a major cause for concern, with a D-W of 1.98, and an R2 of .94 the estimates for the United Kingdom are the best statistical fit.

Table 1. *OLS Results for Demand for Currency Ratio 1870-1913*

	UK	Norway	Sweden	US
Dependent Variable	$C/M2_{t-1}$	$C/M2_{t-1}$	$C/M2_{t-1}$	$C/M2_{t-1}$
Income per capita $_{t-1}$ *(Y/Capita)*	1.115***	0.367***	-0.455***	-1.466***
	(0.164)	(0.0591)	(0.102)	(0.104)
Interest Rate $_{t-1}$ *(R)*	-0.000772	-0.185***	0.965***	-0.411***
	(0.129)	(0.0436)	(0.219)	(0.0828)
Wages $_{t-1}$ *(Wages)*		-0.193	0.394	0.0952
		(0.120)	(0.377)	(0.349)
Tax Burden *(1+T)*	0.122***	2.763**	4.151**	9.036***
	(0.0391)	(1.205)	(2.015)	(2.712)
Welfare $_{t-1}$ *(WELFARE)*	0.233***			
	(0.0691)			
Total Expenditure $_{t-1}$ *(TOTEXP)*				-0.754***
				(0.0865)
Constant	-11.50***	-3.748***	-0.159	12.44***
	(1.284)	(0.731)	(1.723)	(1.449)
Observations	31	42	42	44
R-squared	0.94	0.74	0.69	.95
D-Watson	1.98	1.71	1.80	1.88

Notes: All variables are in natural log. Regression coefficients are displayed with standard errors in parentheses.
***, **, * indicate significance at the 1, 5 and 10 percent level respectively.
Source: Own Calculations

Calculation of the Size of the Shadow Economy over 1870-2013

In order to obtain estimates of the size of the shadow economy we use the following method: For each year the predicted level of the currency ratio C/M2 can be calculated using the regression equations found in table X. The predicted level of currency holding – $\hat{C}$ – can be calculated given the actual figure for M2 following the method used by Tanzi (1980):

Let the dependent variable in the preceding econometric equation be represented by Z. Therefore

$$Z = \ln(C/M2) = \ln C - \text{Ln } M2$$

If we rewrite this equation in terms of lnC we get

$$\ln C = Z + \ln M2$$

where the circumflex above the C represents the predicted value from the econometric equation, solving this equation results in:

$$\hat{C} = \exp(Z + \ln M2)$$

This represents the value of currency at time t predicted by the econometric equations. The next step is to set the tax variable equal to its lowest value, keeping all the other coefficients unchanged to obtain Ć, the predicted level of currency in circulation without taxes. This is done by following the same procedure outlined above. The difference between the two variables $\hat{C}$ and Ć gives us the amount of extra currency in the economy.

Using the Ahumada *et al.,* (2007) approach of circumventing the issue of differing velocities of money between the legal and illegal economy

$$\frac{Y_{informal}}{Y_{formal}} = \left(\frac{C_{informal}}{C_{formal}}\right)^{\frac{1}{\alpha}} = \left(\frac{Y_{informal}}{Y_{formal}}\right)^{\frac{1}{\alpha}}$$

$$\left(\frac{17.32}{133}\right)^{\frac{1}{1.115}} = .168 = 16.8\%$$

This implies that the size of the UK shadow economy as a percentage of UK GDP in 1884 was 16.8%. This process is repeated for the remaining years and the remaining countries to produce estimates for the size of the shadow economy. These are presented in Figures 6 below.

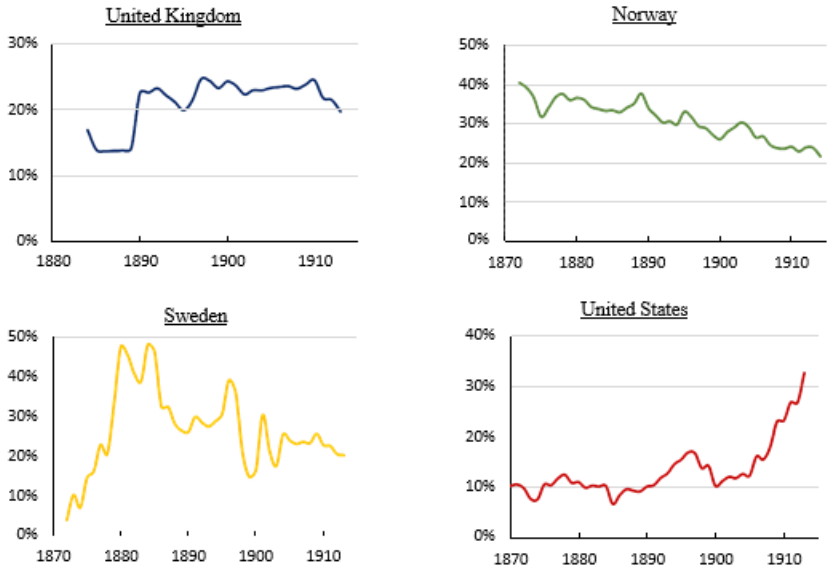


Figure 6. *Shadow Economy as a percentage of GDP 1870-1913*

Figure 6 depicts a wide variation in the size of shadow economies across the panel of countries. In the case of the United States the shadow economy remained relatively stable (approximately 10 percent of GDP) from 1870 until 1905 before it began to increase to close to 30 percent of GDP at the start of World War 1. The United Kingdom also remained relatively stable after 1890 at just over 20 percent of GDP. Norway displays a pronounced downward trend in the size of its shadow economy, from 40 percent of GDP in 1970 to 24 percent before the start of World War 1. Sweden on the other hand displays a very erratic shadow economy that fluctuates from between 4 and 47 percent of GDP. The Swedish and Norwegian shadow economies experienced a small increase in the year after the peaceful dissolution of their Union in 1905. However, it does begin to stabilise towards the end of the period.

The three European shadow economies in the panel show signs of convergence towards the end of the period.

4.2. From the Somme to Saigon 1913-1970

The next period under examination is 1913-1970. This period is more interesting than the 1880-1913 period discussed above due to the major shifts in geopolitics and ideologies, brought about by two major international conflicts as well as the Great Depression of 1931. To capture the long run effects of the explanatory variables on currency demand the following econometric equation has been estimated:

$$C/M2 = \alpha 0 + \alpha 1(Y/capitat) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(REGt) + \alpha 5(UNEMPt) + \alpha 6(CRIMEt) + (TOTEXP) + \varepsilon t \quad (4)$$

The model for Sweden is displayed in equation (5), all variables are in natural logarithms and the dependent variable is again C/M2 . For Sweden the model run is similar to the United Kingdom except that a variable capturing the effects of the self-employment rate (SELF) on the currency ratio is included.

$$C/M2 = \alpha 0 + \alpha 1(Y/capitat) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(REGt) + \alpha 5(SELFt) + \alpha 6(WAGESt) + \varepsilon t \quad (5)$$

The model used to estimate the US shadow economy is a VEC model where the dependent variable is again the natural logarithm of C/m2. The usual due diligence steps were taken to ensure Unit Root and Cointegration.

$$C/M2 = \alpha 0 + \alpha 1(Y/Capitat) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(WELFAREt) + \alpha 5(WAGES) + \alpha 6(CRIMEt) + \alpha 7(UNEMP) + \varepsilon t \quad (6)$$

Only four explanatory variables are employed in the case of the Norway 1913-1970 due to data limitations. This is quite disappointing since it would be interesting to compare both Scandinavian countries which are culturally and economically similar. However, an OLS model is run using a skeleton similar to Tanzi (1980) and employed in the 1870-1913 period:

$$C/M2 = \alpha 0 + \alpha 1(Y/Capita_t) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(WAGESt) + \varepsilon t \quad (7)$$

Econometric results

The coefficients of the previous four econometric equations are displayed in Table 2 below. The relationship between economic development and the currency ratio is statistically significant negative in the case of the Scandinavian countries and the US, implying that the shadow economy is counter-cyclical to economic growth. The opposite is true in the UK. The interest rate is negative yet insignificant in the UK, Norway and Sweden but positive and significant at the 1 percent level in the US, implying that an increase in interest rate leads to an increase in the currency ratio in the long term. Self-employment leads to a decrease in the currency ratio in Sweden, this is statistically significant however there is no data available for other countries to check the robustness of this variable, so it could potentially be a spurious correlation. Unemployment is significantly positively correlated with the currency ratio at the 1 percent level. Incidence of fraud which proxies for morality of paying taxes is positively significantly associated with the currency ratio, implying that an increase in fraud in a country increases the currency ratio.

Table 2. *Normalized Cointegrating Coefficients 1913-1970*

Dependent Variable	$C/M1^a_{t-1}$	$C/M2^a_{t-1}$	$C/M2^b_{t-1}$	$C/M2^b_{t-1}$
	1.00	OLS	1.00	1.00
Income $_{t-1}$	15.73*	-0.847**		
	(8.35)	(0.42)		
Income per capita $_{t-1}$ *(Y/Capita)*			-1.866***	-0.678***
			(0.41)	(0.14)
Interest Rate $_{t-1}$ *(R)*	-2.745	-0.434	-0.452	0.466***
	(4.13)	(0.33)	(0.29)	(0.06)
Public Sector $_{t-1}$ *(REG)*	-58.53***		-2.009***	
	(12.57)		(0.38)	
Tax Burden $_{t-1}$ *(1+T)*	54.26***	4.315**	4.036***	1.059*
	(13.5)	(1.68)	(1.32)	(0.60)
Self-Employment $_{t-1}$ *(SELF)*			-1.904***	

			(0.66)	
Unemployment $_{t-1}$ *(UNEMP)*	3.058*** (1.16)			2.538*** (0.58)
Fraud Incidence $_{t-1}$ *(CRIME)*	0.130** (0.07)			0.358*** (0.11)
Wages in National Income $_{t-1}$ *(WAGES)*		-1.554*** (0.53)	6.079*** (0.64)	-4.732*** (1.72)
Welfare $_{t-1}$ *(WELFARE)*				0.442*** (0.15)
Total Expenditure $_{t-1}$ *(TOTEXP)*	-1.725*** (0.32)			
Constant	12.52*** (2.58)	14.21** (6.16)	8.055 (5.38)	27.45*** (5.93)
Observations	56	55	58	58
Log Likelihood *(D-Watson)*	823.01	(2.01)	922.84	674.99
X^2	189.77	-	336.23	425.70
Trace Statistic 5%	2	-	1	3
Max Eigenvalue Statistic 5%	2	-	1	3

Notes: All variables are in natural logs. Standard Errors presented in parentheses.
*, **, *** indicate significance at the 10, 5, and 1 percent level respectively.
The number of lags in the models were determined using Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC) and the Hannan and Quinn information criterion (HQIC).
a The model was run with 1 lag.
b The model was run with 4 lags.
Source: own calculations

Calculation of the Size of the Shadow Economy over 1913-2015

After estimating the VECM and having obtained the coefficients displayed in Table 3 we can now calculate the size of the shadow economy. The first step again is to calculate $\hat{C}$, the predicted level of currency holding using the method outlined in the previous section. We then set the tax burden, public sector employment and in the case of Sweden, self-employment, to the minimum level to obtain $\acute{C}$. The difference between $\hat{C}$ and $\acute{C}$ gives us the extra currency in circulation in the respective economies.

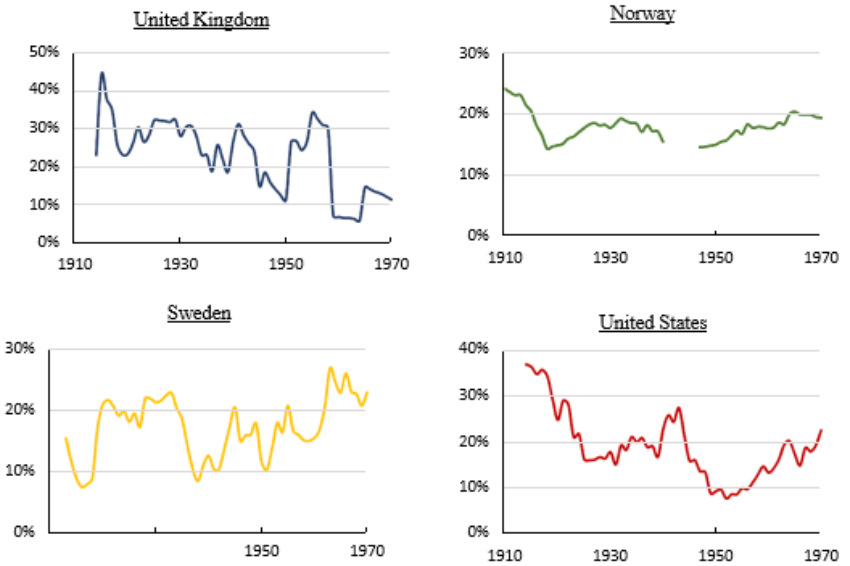


Figure 7. *Shadow Economy as a percentage of GDP 1913-2015*

There are again wide fluctuations in the size of the shadow economies in the panel of countries. Norway has a relatively stable shadow economy over the period although missing data for Norwegian GDP during World War Two means we do not have estimates for this period. In the US and the UK underground activity increased by approximately 10 percentage points between 1940 and 1941. The

UK had the largest shadow economy as a percentage of GDP in 1915 at 44 percent of GDP, it then rose again spectacularly between 1950 and 1960 (to over 30 percent of GDP). The shadow economies in Norway, Sweden, and the united states converged to approximately 20 percent of GDP in 1970.

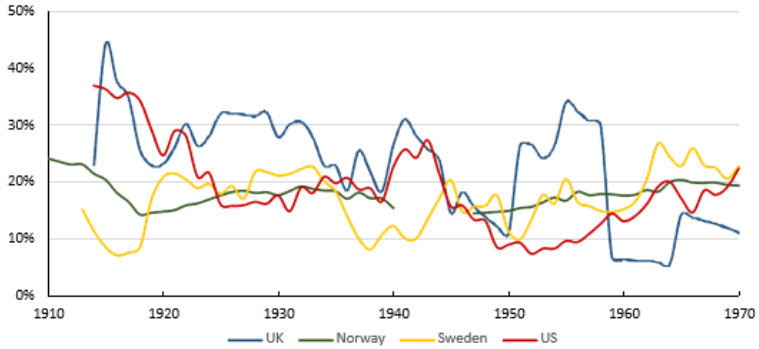


Figure 8. *Shadow Economies as a percentage of GDP 1910-1970*

4.3. From aigon to the sub-prime crisis 1970-2015

The most recent period benefits from better quality data, much of which has been gleaned from the OECD website. The Tax Burden in the following equations is a variable available on the OECD website and it encompasses the various forms of taxes that individuals are subject to in each country. The significance and expected sign of all other variables have been discussed at length in previous sections and reiteration would be futile. The VEC model has been used to estimate the currency ratio for the panel of countries.

United Kingdom

$$C/M2 = \alpha 0 + \alpha 1(Yt) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(REGt) + \alpha 5(SELFt) + \alpha 6(CRIMEt) + \alpha 7(TOTEXP) + \varepsilon t$$

Norway

$$C/M2 = \alpha 0 + \alpha 1(Y/Capitat) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(REGt) + \alpha 5(SELFt) + \alpha 6(CRIMEt) + \alpha 7\,(TOTEXP) + \varepsilon t$$

Sweden

$$C/M2 = \alpha 0 + \alpha 1(Yt) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(REGt) + \alpha 5(SELFt) + \alpha 6(CRIMEt) + \alpha 7(TOTEXP) + \varepsilon t$$

United States

$$C/M2 = \alpha 0 + \alpha 1(Y/Capitat) + \alpha 2Rt + \alpha 3(1+TAXt) + \alpha 4(REGt) + \alpha 5(SELFt) + \alpha 6(CRIMEt) + \alpha 7(WELFARE) + \varepsilon t$$

The results of the VECM are displayed in Table 3. Economic development is implied to be significantly, positively correlated with the currency ratio, as is the interest ratio which seems counterintuitive however the VEC model captures the long run effect which implies that in the long run the currency ratio is positively correlated with the interest rate. In the UK and Norway, the regulatory burden is negatively correlated with the currency ratio, implying that increased regulation disincentivizes shadow economic activity since the detection rate is higher, while the reverse is true in Sweden and the US. The Tax Burden is negatively correlated with the currency ratio in Norway and the US. This is significant at the 1 percent level. This is counterintuitive but it may imply that in Norway and the US there are other factors such as regulation and spending on welfare that are more important determinants of shadow economic activity than simply the tax burden alone.

Table 3. *Normalized Cointegrating Coefficients 1970-2015*

Dependent Variable:	$C/M2_{t-1}$	$C/M2_{t-1}$	$C/M2_{t-1}$	$C/M2_{t-1}$
	1.00	1.00	1.00	1.00
$Income_{t-1}$	1.201***		1.688***	
	(0.22)		(0.05)	
$Income\ per\ capita_{t-1}$ *(Y/Capita)*		3.362***		2.324***
		(0.86)		(0.29)
$Interest\ Rate_{t-1}$ *(R)*	0.664***	0.176	0.387***	0.484***
	(.09)	(0.18)	(0.03)	(0.08)
$Public\ Sector_{t-1}$ *(REG)*	-3.407***	-3.388***	0.724***	4.333***
	(.34)	(1.14)	(0.17)	(0.84)
$Tax\ Burden_{t-1}$ *(1+T)*	3.493*	-9.839***	4.172***	-33.04***
	(2.03)	(2.55)	(0.20)	(2.40)
$Self\text{-}Employment_{t-1}$ *(SELF)*	1.339***	-1.446**	1.777***	3.179***
	(.11)	(0.71)	(0.07)	(0.46)
$Fraud\ Incidence_{t-1}$ *(CRIME)*	.085	0.296**	-0.0306*	0.195***
	(.056)	(0.13)	(0.02)	(0.03)
$Welfare_{t-1}$				0.0255
				(0.10)
$Total\ Expenditure_{t-1}$	0.795***	-4.172***	-0.686***	
	(.27)	(1.21)	(0.07)	
Constant	-12.62***	12.08*	-28.87***	-34.15***
	(2.71)	(6.35)	(0.94)	(5.11)
Observations	47	46	47	46
Log Likelihood	857.13	882.85	799.44	991.23
X^2	659.97	478.94	397.19	297.79
Trace Statistic 5%	2	3	2	2
Max Eigenvalue Statistic 5%	2	1	1	1
Lags	1	1	4	4

Notes: All variables are in natural logs. Standard Errors presented in parentheses.
*, **, *** indicate significance at the 10, 5, and 1 percent level respectively.
The number of lags in the models were determined using Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC) and the Hannan and Quinn information criterion (HQIC).
a significant at the 5% level
b significant at the 1% level
Source: Own calculations.

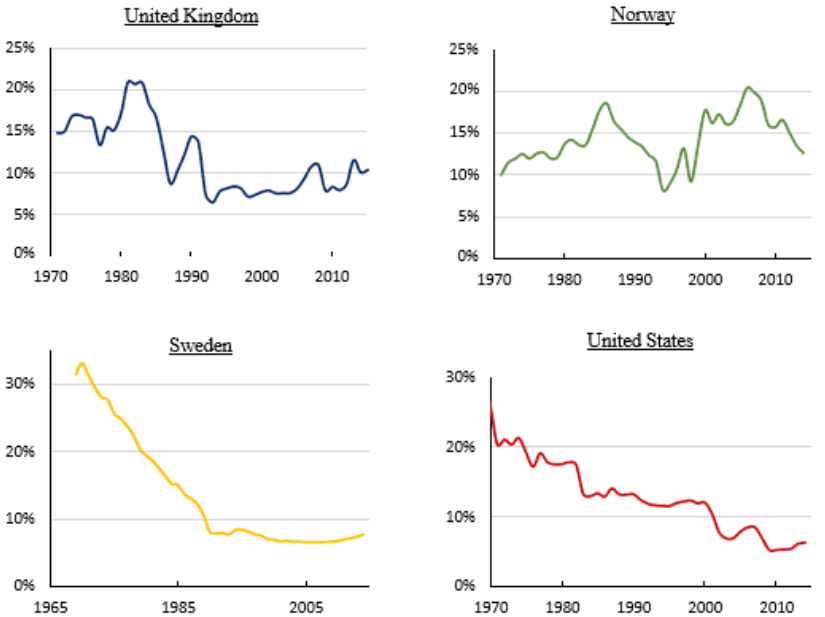


Figure 9. *Shadow Economy as a percentage of GDP 1970-2015*

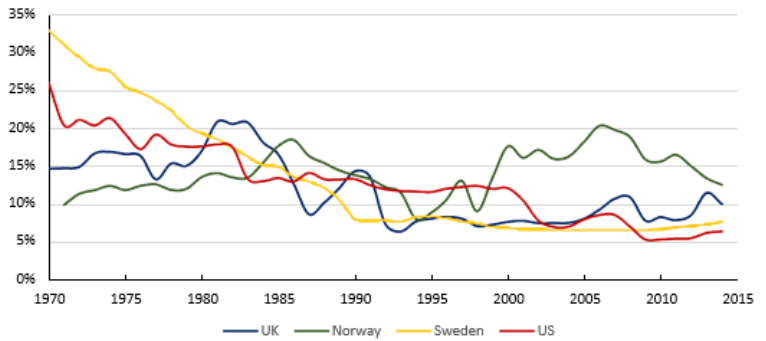


Figure 10. *Shadow Economies as a percentage of GDP 1970-2015*

Estimation Results of the Shadow Economy over 1970-2015

With the exception of Norway, shadow economies in the panel of countries appear to be decreasing. The most pronounced downward trend is in Sweden which had an illegal sector measuring 33 percent of GDP in 1970 that fell to

approximately 7-8 percent of GDP in 1990 and has only mildly fluctuated since then. The UK and the US show signs of receding shadow economies also, though a small increase is visible between 2005 and 2010 which can more than likely be attributed to insolvent banks in America which sent shockwaves across the Atlantic in the form of exposure to complex financial instruments. The Norwegian Shadow economy reaches a local high of 20 percent of GDP in 2007 before receding to approximately 14 percent of GDP in 2014. Norway has been shown by Schneider (2005) to have one of the largest shadow economies of European OECD countries and a report by the Norwegian Lawyers Association (2015) has found that the Norwegian Shadow Economy was the second largest in Europe, at approximately 15% of GDP, equating to an additional NOK 420 billion in circulation.

4.4. Limitations of our results

Dollarization

One may wonder about the effects of "dollarization" in the panel of countries during the time period at hand, that it the use of dollars instead of the national currency in the country at that time.

Dollarization was largely confined to countries which experienced hyperinflation6 and given that none of the countries within the panel experienced hyperinflation (Figure 15) during this period, this can be (largely) ruled out.

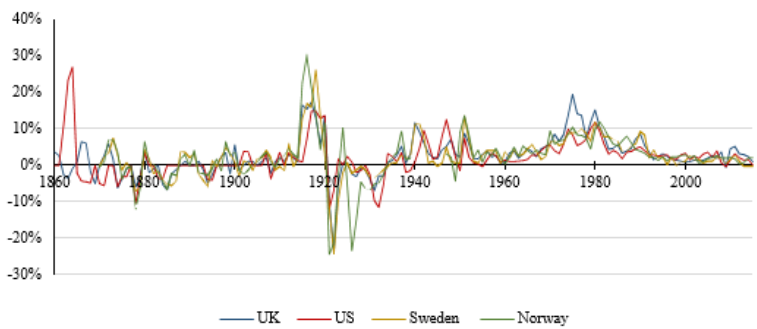


Figure 11. *Inflation Rates 1860-2015*

Comparing Apples and Oranges

One may be concerned about the differences in variables across different time periods. Can we really compare the size of the shadow economy before the advent of income tax in 1880, to the shadow economy in 1980 when income taxes are recognised as a man driver or underground activity? In effect, are we comparing apples and oranges? Comparisons across such long periods may be as difficult to compare the results between countries during a particular period. This is one reason why we split up the two periods in the three periods 1870 to 1913, 1914 to 1970 and 1971 to 2015.

Omitted Variables

While many of the models indicate strong "goodness-of-fit" there may be a problem of omitted variable bias. In the period 1870-1913, data on import tariffs and smuggling could provide more accurate results however these data were not available. Similarly, the period 1970-2015 could've benefitted greatly if it were possible to control for spending with forms of plastic money (credit cards, debit cards) as well as cheques as these forms of payment would decrease the need to hold currency.

Assumptions of Currency Demand Approach

There are of course also weaknesses associated with the currency demand approach in modelling the shadow economy. For one, the assumption of a base year without any shadow economic activity is a strong assumption. Add to this the fact that not all shadow economic activities are paid for in cash and it is possible that we may be underestimating the size of the shadow economy.

5. Summary and Conclusions

"They can't collect legal taxes from illegal money."
Al Capone. (Kobler, 1972)

Shadow economies in the United Kingdom, Norway, Sweden and the United States have experienced wide fluctuations over the past 150 years, from wartime booms to depression lows. One aspect that may bring relief to policymakers is that shadow economies as a percentage of GDP show a pronounced downward trend and less fluctuations than in the pre-World War II period.

In terms of what the future holds for the shadow economy the forecast is rather nebulous. On the one hand the world is become more and more technological. Financial innovation is reducing the need to carry cash, leading to greater accountability of where and in what way individuals spend their money. Electronic footprints make it more difficult for individuals to spend money anonymously. One thing that is for sure is that cash aids and abets the existence of a shadow economy through the anonymity associated with holding it. Large denomination bills are the most widely used in illicit activities (Rogoff, 2014) and the tax burden is believed to be a main driver of underground activity. Whether this result holds in the future is open. Rogoff (2014) argues that the

removal of large denomination bills could be more effective than tax reforms in reducing the size of the shadow economy. If this were to occur small denomination notes and coins could remain in circulation to be used for everyday transactions while larger transactions would be carried out electronically. The impracticality of paying for underground goods and services in small denomination notes could potentially disincentivize individuals from participating in the shadow economy. However, as long as the reasons, why people are engaged in shadow economic activities, are not eliminated, the decline in shadow economy will be modest, if only cash is abolished The move towards a cashless society would also mean greater economic control for monetary policy makers, since it would allow central bankers greater scope to make deeper cuts to real interest rates in severe downturns (Rogoff, 2014).

While the shadow economy looks set to become less of a concern to policymakers there is no cause for celebration just yet. To use a second adage, necessity is the mother of invention. Individuals will always find a way to circumvent rules and regulations if they find them unfavourable. The rise of Bitcoin and The Dark Web facilitate anonymous, illicit transactions online.

One thing that is for sure though is that GDP as a measure of a country's worth is an extremely fickle indicator. It is a blank canvas onto which countries can paint the self-portrait they would like others to see. Countries have incentives to inflate their size of their economies, in addition quashing citizens demands for increased spending by highlighting that their debt-to-GDP is higher than average, countries can also use distorted GDP figures to keep their debt and deficits within prescribed European Union targets. GDP is an all-encompassing figure that includes money spent on activities that generate negative externalities such as pollution, money spent on medical drugs that do not work are also included in GDP but they don't reflect an improvement in national welfare.

In terms of further research on this matter, if a consistent data series on electronic payments could be created it would

provide much more accurate estimates of the size of the shadow economy post-1970, as well as attempting to find a better cross-country comparative indicator than GDP.

Finally, while shadow economies are shrinking in size, their decrease may have reached a plateau if not for radical intervention in the form of moves towards a cashless society. A strong and worrying prospect is that shadow economic activity is a cultural phenomenon, depending on nationality. Seen as a victimless crime it is cultured from an "us vs them" siege mentality, deeply embedded in the psyche of the individuals who partake in these activities. Tax reforms and monetary policies are easily adjusted. The recalibration of a moral compass is a much more complex matter.

Appendix

Appendix A. Detailed Results – United Kingdom

All calculations are authors own unless otherwise stated:

Table A1. *Shadow Economy estimates 1884-2015.*

(1) Size of the shadow economy as a percentage of GDP

(2) The monetary value of the shadow economy in real terms (2012 prices)

	(1)	(2)		(1)	(2)		(1)	(2)		(1)	(2)
Year	% of GDP	£ mn	Year	% of GDP	£ mn	Year	% of GDP	£ mn	Year	% of GDP	£ mn
1884	16.8%	22,323	1921	26.2%	48,929	1958	30.2%	132,993	1995	8.1%	95,750
1885	13.8%	18,211	1922	30.4%	59,634	1959	7.0%	32,148	1996	8.4%	101,002
1886	13.6%	18,027	1923	26.6%	53,703	1960	6.7%	32,499	1997	8.1%	101,465
1887	13.6%	18,814	1924	28.2%	59,735	1961	6.5%	32,293	1998	7.2%	92,084
1888	13.7%	19,517	1925	32.2%	70,501	1962	6.4%	32,527	1999	7.4%	97,577
1889	14.0%	20,601	1926	32.1%	68,261	1963	6.2%	32,707	2000	7.7%	106,244
1890	22.5%	33,429	1927	32.0%	73,209	1964	5.7%	32,082	2001	7.9%	111,341
1891	22.5%	34,248	1928	31.7%	73,240	1965	14.4%	82,586	2002	7.5%	109,503
1892	23.2%	34,540	1929	32.4%	76,820	1966	14.0%	81,178	2003	7.6%	113,485
1893	22.1%	32,750	1930	28.1%	66,059	1967	13.3%	79,616	2004	7.6%	116,592
1894	21.1%	32,684	1931	30.3%	68,021	1968	12.9%	81,052	2005	8.1%	128,779
1895	19.8%	31,760	1932	30.7%	68,998	1969	12.1%	77,822	2006	9.3%	151,663
1896	21.3%	35,561	1933	28.0%	64,999	1970	14.8%	97,341	2007	10.8%	179,632
1897	24.6%	41,476	1934	23.0%	56,592	1971	14.8%	100,945	2008	11.0%	182,020
1898	24.3%	42,908	1935	23.1%	58,716	1972	15.0%	106,610	2009	7.9%	125,289
1899	23.2%	42,406	1936	18.7%	49,987	1973	16.8%	127,037	2010	8.3%	134,591
1900	24.2%	44,120	1937	25.6%	70,806	1974	17.0%	125,391	2011	7.9%	130,703
1901	23.6%	43,890	1938	22.0%	61,174	1975	16.7%	121,263	2012	8.6%	143,837
1902	22.3%	42,015	1939	18.6%	53,951	1976	16.4%	123,171	2013	11.5%	196,451
1903	22.9%	42,827	1940	26.6%	84,995	1977	13.4%	102,603	2014	10.1%	176,296
1904	22.9%	43,253	1941	31.2%	108,254	1978	15.4%	123,451	2015	10.3%	185,269
1905	23.2%	45,231	1942	28.2%	99,661	1979	15.1%	125,502			
1906	23.4%	46,666	1943	26.0%	93,490	1980	17.1%	138,874			
1907	23.5%	47,810	1944	24.0%	82,488	1981	20.9%	168,372			
1908	23.1%	45,265	1945	14.8%	48,540	1982	20.7%	169,816			
1909	23.7%	47,574	1946	18.4%	58,996	1983	20.9%	178,594			
1910	24.5%	50,287	1947	15.9%	50,095	1984	18.3%	159,768			
1911	21.7%	46,168	1948	14.0%	45,792	1985	16.7%	151,715			
1912	21.4%	46,140	1949	12.5%	41,976	1986	12.8%	120,260			
1913	19.7%	44,106	1950	11.1%	38,714	1987	8.7%	86,666			
1914	23.1%	52,852	1951	26.5%	95,772	1988	10.2%	107,572			
1915	44.3%	106,920	1952	26.7%	98,011	1989	12.2%	131,510			
1916	37.8%	92,309	1953	24.3%	94,277	1990	14.4%	156,015			
1917	35.0%	84,881	1954	26.6%	107,259	1991	13.7%	146,312			
1918	25.8%	63,719	1955	34.1%	143,097	1992	7.4%	80,059			
1919	23.1%	52,665	1956	32.6%	138,916	1993	6.4%	71,021			
1920	23.4%	50,107	1957	30.9%	134,374	1994	7.8%	89,008			

Table A2. *Definition of Monetary Aggregates*

	United Kingdom
Variable	Definition
M0	Notes and coins in circulation with the non-bank public.
M1	M0 plus sterling current accounts held by the private sector only, excluding those held by the public and overseas sector.
M2	M1 plus time deposit accounts of private sector UK residents with deposit banks.
M3	Non-bank holdings of notes and coins plus all deposits of all residents (both private and public sectors) with the UK banking sector including sight and time deposits in sterling and foreign currency, and time deposits with accepting houses, overseas bank and otherbanks).

Table A3. *Data Sources*

	United Kingdom		
	1880-1913	1913-1970	1970-2015
Variable:			
Monetary Aggregates	Samuel H. Williamson, "What Was the U.K. GDP Then?" Measuring Worth, 2016. URL: [Retrieved from].		
GDP	Schularick & Taylor (2012) supplemented by Bank of England data		
Interest Rate	Mitchell International Historical Statistics, Europe 1750-2000	Piketty, Thomas, "Capital inthe 21st Century, Harvard University Press", (2014).	OECD [Retrieved from]
Tax Burden			
Self-Employment Rate		Office of National Statistics	OECD
Unemployment Rate		Office of National Statistics, Denman (1996)	OECD
Total GovernmentExpenditure		[Retrieved from].	
Total WelfareExpenditure		[Retrieved from].	
Size of Public Sector			OECD
Fraud Incidence		[Retrieved from].	
Wages and Salaries innational Income	National Archives, Office of National Statistics		

Table A4. *Unit Root Test*

Variable	United Kingdom 1913-1970					
	At Level			First Difference		
	Intercept	Trend and Intercept	No TrendNo Intercept	Intercept	Trend and Intercept	No Trend No Intercept
C/M2	-1.726	-1.078	0.346	-7.091***	-7.261***	-7.127 ***
Y	1.247	-1.161	1.949*	-5.089***	-5.260***	-4.403***
R	0.230	-0.359	1.662	-6.070***	-6.174***	-5.913***
Tax	-2.126	-1.411	0.885	-4.430***	-4.544***	-4.322***
UNEMP	-2.123	-2.066	-1.923	-6.438***	-6.386***	-6.494***
WELFARE	-1.396	-2.035	0.496	-4.771***	-4.721***	-4.734***
REG	-1.967	-1.726	0.920	-1.967***	-1.726***	0.920***
FRAUD	-1.028	-1.248	-0.313	-2.028**	-2.248 **	-0.313**

Variable	United Kingdom 1970-2015					
	At Level			First Difference		
	Intercept	Trend and Intercept	No Trend No Intercept	Intercept	Trend and Intercept	No Trend No Intercept
C/M2	-0.617	-0.931	2.476 **	-4.788***	-4.742 ***	-4.353 ***
Y	-0.875	-2.695	4.903***	-7.440***	-7.431 ***	-5.152 ***
R	-0.936	-2.973	-0.751	-7.250***	-7.662***	-7.210 ***
Tax	-2.997*	-3.508 *	2.024 **	-5.303***	-5.336 ***	-5.084 ***
REG	-2.661*	-1.751	0.222	-5.656 ***	-6.049***	-5.717 ***
SELF	-1.411	-1.097	2.060**	-5.568***	-5.640 ***	-5.167***
TOTEXP	-1.703	-1.772	0.114	-4.925***	-4.871***	-4.979***
FRAUD	-1.427	-0.924	-0.293	-4.115***	-4.157 **	-4.157***

Notes: Reported above are the T-statistics for the Augmented Dicky-Fuller (ADF) test.Null hypothesis: variable has unit root.
The lag length was chosen using the Schwarz Information Criterion.
*, **, *** indicate significance at the 10, 5, and 1 percent level respectively.
Source*: Own calculations*

Table A5. *Stability analysis*

	Cointegrating Coefficients United Kingdom					
	1913-1970			1970-2015		
Dependent Variable	C	C/M1	C/M1	C/M1	C/M2	C/M2
C/M1	1.00	1.00	1.00	1.00	1.00	1.00
Y/capita (real income/capita)	3.410***				-0.611***	
	(1.01)				(.12)	
Y (real income)		-5.459***	-0.136	1.406***		1.330***
		(1.86)	(.67)	(.25)		(.45)
R (interest rate)	1.921***	-0.489***	1.622***	0.819***	-0.492***	0.185***
	(.42)	(.12)	(.29)	(.1)	(.05)	(.03)
TAX2 (Top Marginal TaxRate)	22.31*	62.36***	36.43***	4.242*	3.367***	10.85**
	(11.5)	(22.8)	(5.53)	(.34)	(1.27)	(5.35)
REG (public employment)			-5.994***	-4.080***	1.191***	-6.663***
			(1.23)	(.40)	(.24)	(.80)
SELF (self-employment)			5.729***	1.475***	0.819***	2.141***
			(.46)	(.13)	(.09)	(.31)
CRIME (fraud incidence)		1.761**	1.903***	0.130**	0.0032	-0.0623
		(.75)	(.18)	(.07)	(.04)	(.16)
SOC (social welfare expenditure)		11.33***	-5.074***			
		(2.14)	(.70)			
GOV (government expenditure)				0.980***	-0.588***	0.166
				(.31)	(.21)	(.67)
UE (Unemployment rate)	0.394**					
	(.15)					
Constant	-42.42***	38.72***	1.249***	-14.78***	5.20**	-5.473***
	(2.56)	(1.78)	(.07)	(2.15)	(1.21)	(.86)
Log Likelihood	180.12	218.51	178.94	225.03	166.83	245.01
Observations	58	55	55	50	47	47
Autocorrelation LM Test	27.55	33.41	27.52	34.62	24.65	39.13
Lags	1	4	4	1	4	4

Appendix B. Detailed Results – Norway
Table B1. Shadow Economy estimates 1872-2015.
(1) Size of the shadow economy as a percentage of GDP
(2) The monetary value of the shadow economy (million NOK) in real terms (2005 prices)

(1) Year	% of GDP	(2) NOK mn	(1) Year	% of GDP	(2) NOK mn	(1) Year	% of GDP	(2) NOK mn	(1) Year	% of GDP	(2) NOK mn
1872	40.4%	15,043	1911	23.6%	18,602	1950	15.0%	38,889	1989	14.5%	177,103
1873	39.1%	14,909	1912	23.1%	19,117	1951	15.5%	42,260	1990	13.9%	172,831
1874	36.6%	14,483	1913	23.1%	20,155	1952	15.7%	44,533	1991	13.4%	171,423
1875	31.8%	12,955	1914	21.5%	19,126	1953	16.5%	49,172	1992	12.3%	163,593
1876	33.9%	14,203	1915	20.5%	18,995	1954	17.3%	54,309	1993	11.6%	158,233
1877	36.7%	15,482	1916	18.2%	17,513	1955	16.8%	53,754	1994	8.1%	116,269
1878	37.6%	15,303	1917	16.6%	14,552	1956	18.3%	61,902	1995	8.9%	133,173
1879	36.1%	14,803	1918	14.4%	12,081	1957	17.8%	61,975	1996	10.7%	167,107
1880	36.6%	15,509	1919	14.7%	14,465	1958	17.9%	62,220	1997	13.1%	216,981
1881	36.2%	15,458	1920	14.9%	15,632	1959	17.9%	65,390	1998	9.1%	154,729
1882	34.3%	14,646	1921	15.1%	14,358	1960	17.7%	68,372	1999	13.5%	233,500
1883	33.8%	14,382	1922	16.0%	16,772	1961	17.8%	73,429	2000	17.7%	315,850
1884	33.3%	14,429	1923	16.3%	17,596	1962	18.6%	79,355	2001	16.2%	295,061
1885	33.5%	14,615	1924	17.0%	18,340	1963	18.3%	81,255	2002	17.2%	318,356
1886	33.0%	14,485	1925	17.7%	20,253	1964	20.0%	93,157	2003	16.1%	299,379
1887	34.1%	15,180	1926	18.3%	21,271	1965	20.4%	100,223	2004	16.4%	317,451
1888	35.2%	16,390	1927	18.5%	22,334	1966	19.9%	101,979	2005	18.3%	364,625
1889	37.7%	18,234	1928	18.2%	22,843	1967	19.9%	108,287	2006	20.4%	415,933
1890	34.0%	16,901	1929	18.3%	25,152	1968	19.9%	111,028	2007	19.9%	416,546
1891	32.1%	16,119	1930	17.8%	26,317	1969	19.6%	114,076	2008	18.9%	398,184
1892	30.4%	15,526	1931	18.5%	25,225	1970	19.4%	118,099	2009	16.0%	330,997
1893	30.7%	16,092	1932	19.3%	27,641	1971	10.0%	64,087	2010	15.7%	327,057
1894	29.9%	15,763	1933	18.9%	27,704	1972	11.4%	77,327	2011	16.6%	348,608
1895	33.1%	17,681	1934	18.6%	28,227	1973	11.9%	84,299	2012	15.1%	325,806
1896	31.8%	17,448	1935	18.4%	29,443	1974	12.5%	91,700	2013	13.5%	293,925
1897	29.4%	17,020	1936	17.1%	29,205	1975	11.9%	92,089	2014	12.6%	280,640
1898	28.9%	16,872	1937	18.2%	32,429	1976	12.5%	101,946	2015		
1899	27.2%	16,358	1938	17.2%	31,350	1977	12.7%	107,816			
1900	26.1%	15,899	1939	17.2%	32,785	1978	11.9%	105,544			
1901	27.9%	17,433	1940	15.5%	30,118	1979	12.1%	111,525			
1902	29.1%	18,463	1941			1980	13.7%	131,630			
1903	30.4%	19,142	1942			1981	14.2%	138,736			
1904	29.2%	18,407	1943			1982	13.6%	133,539			
1905	26.6%	16,879	1944			1983	13.5%	138,288			
1906	26.9%	17,773	1945			1984	15.5%	167,892			
1907	24.7%	17,029	1946			1985	17.7%	202,795			
1908	23.9%	17,013	1947	14.5%	32,523	1986	18.6%	220,652			
1909	23.7%	17,277	1948	14.7%	35,084	1987	16.5%	198,996			
1910	24.2%	18,354	1949	14.8%	36,509	1988	15.5%	187,009			

Table B2. *Definition of Monetary Aggregates*

	Norway	
Variable:	Definition:	Additional remarks:
Mo	Total currency in circulation (notes andcoins) plus total demand deposits at Norges Bank, excluding Treasury deposits.	The data also includes currency in the hands of the public which I will treat as Mo in the UK sense of the word.
M1	An M1 variable does not exist however one has been created to the UK definitionusing the Norwegian definition of Mo.	
M2	M2 is defined as total currency in circulation minus currency held by banksplus savings and commercial bank deposits.	

Table B3. *Data Sources*

	Norway		
Variable	1870-1913	1913-1970	1970-2015
Monetary Aggregates	Eitrheim, Ø , Klovland J.T, & Qvigstad F.S (2003) "Historical Monetary Statistics forNorway 1819-2003" Norgesbank Occasional Paper No.35.		
GDP	Norgesbank, 2016		
Interest Rate	Schularick & Taylor (2012) supplemented by Norgesbank data		
Tax Burden	Historical Statistics, Europe 1750-2000.		OECD
Self-Employment Rate		Measurement and Behaviour of Unemployment, NBER Series, C 2649.	OECD
Unemployment Rate		"	OECD
Total Government Expenditure		NBER working paper, 15982.	OECD
Total Welfare Expenditure			OECD
Size of Public Sector		Public Spending in the 20th Century: A Global Perspective Lugder, V. (2000)	OECD
Fraud Incidence		*Punishment and Crime in Scandinavia, 1750–2008* (Von Hofer, 2013) supplemented with *Nordic Criminal Statistics 1950-2015.*	
Wages and Salaries in national Income	[Retrieved from].		

Table B4. *Unit Root Test*

Variable	Norway 1970-2015					
	At Level			First Difference		
	Intercept	Trend and Intercept	No Trend No Intercept	Intercept	Trend and Intercept	No Trend No Intercept
C/M2	-1.26	-0.282	5.122	-3.337**	-3.454**	-2.574**
Y/Cap	-2.381	-2.311	-0.662	-7.783***	-7.738***	-7.867***
R	-0.225	-1.44	-0.701	-7.823***	-8.700***	-7.824***
Tax	-0.664	-1.603	-0.773	-4.985***	-4.948***	-5.001***
SELF	-1.984	-1.458	-4.315*	-7.210***	-7.638***	-5.599***
REG	-2.971*	-0.278	2.738 *	-4.824***	-5.959***	-3.934***
TOT EXP	-2.389	-2.771	1.303	-6.046***	-6.038***	-5.923***
FRAUD	-0.819	-3.423*	0.287	-3.733***	-3.708**	-10.006***

Notes: Reported above are the T-statistics for the Augmented Dicky- Fuller (ADF) test. Null hypothesis: variable has unit root.
The lag length was chosen using the Schwarz Information Criterion.
*, **, *** indicate significance at the 10, 5, and 1 percent level respectively.
Source: Own calculations

Table A5. *Stability analysis*

	Cointegrating Coefficients United Kingdom				
	1913-1970		1970-2015		
Dependent Variable	C	C/M2	C	C/M2	C/M2
Y/capita (real income/capita)	-2.14***		2.21***	1.38**	
	(0.08)		(.58)	(.80)	
Y (real income)		-.865-***			2.501***
		(.16)			(.09)
R (interest rate)	-0.466	-.55**	.121	.245*	0.287
	(.34)	(.37)	(.11)	(.15)	(.02)
TAX2 (Top Marginal TaxRate)	2.745**	1.059*	1.339***	-5.21*	9.839***
	(.33)	(.59)	(.12)	(3.26)	(2.55)
REG (public employment)			0.724***		
			(.15)		
SELF (self-employment)			-1.438***		-.0641
			(.69)		(.16)
CRIME (fraud incidence)	.129***				
SOC (social welfare expenditure)				3.501*	1.381***
				(2.03)	(.41)
GOV (government expenditure)			.194		
			(.17)		
UE (Unemployment rate)	0.16**	.466**		.231***	
	(.09)	(.08)		(.05)	
Constant	4.32**	16.01***	12.412***	14.93***	14.17***
	(1.70)	(3.34)	(1.17)	(.83)	(1.70)
Log Likelihood			228.95	183.57	250.96
Observations	58	58	50	47	47
Autocorrelation LM Test			35.028	28.1218	41.08
Lags	1	1	1	4	4

Appendix C. Detailed Results - Sweden

Table C1. *Shadow Economy estimates 1872-2015.*

(1) Size of the shadow economy as a percentage of GDP

(2) The monetary value of the shadow economy (million NOK) in real terms (2005 prices)

	(1)	(2)		(1)	(2)		(1)	(2)		(1)	(2)
	% of GDP	SEK mn	Year	% of GDP	SEK mn	Year	% of GDP	SEK mn	Year	% of GDP	SEK mn
1872	10.4%	7,251	1911	20.6%	37,797	1950	11.5%	59,654	1989	10.7%	180,302
1873	7.2%	5,238	1912	20.3%	38,684	1951	10.0%	54,021	1990	8.2%	139,673
1874	14.6%	10,514	1913	15.2%	30,867	1952	13.5%	73,886	1991	8.0%	134,557
1875	16.3%	12,000	1914	11.5%	23,204	1953	17.8%	99,714	1992	8.0%	133,178
1876	23.0%	18,021	1915	8.7%	17,994	1954	16.3%	96,939	1993	7.8%	127,228
1877	20.7%	16,104	1916	7.2%	15,957	1955	20.6%	126,627	1994	8.5%	142,273
1878	33.3%	25,715	1917	7.7%	14,932	1956	16.6%	105,208	1995	8.5%	148,395
1879	47.5%	39,361	1918	8.7%	16,442	1957	15.8%	102,705	1996	8.3%	145,489
1880	45.5%	36,403	1919	17.0%	32,769	1958	15.0%	99,244	1997	7.9%	141,625
1881	40.7%	33,344	1920	20.9%	42,086	1959	14.8%	103,533	1998	7.6%	141,911
1882	38.8%	31,212	1921	21.6%	39,189	1960	15.3%	111,395	1999	7.2%	138,252
1883	48.0%	41,452	1922	20.5%	41,571	1961	16.6%	127,886	2000	7.1%	142,342
1884	46.2%	39,973	1923	19.0%	39,811	1962	20.4%	164,881	2001	6.8%	143,960
1885	32.5%	29,011	1924	19.7%	43,634	1963	26.8%	228,273	2002	6.9%	147,326
1886	32.5%	28,938	1925	18.0%	39,844	1964	24.5%	223,933	2003	6.8%	150,200
1887	28.2%	24,843	1926	19.4%	45,857	1965	22.8%	216,783	2004	6.8%	155,581
1888	26.5%	24,512	1927	17.1%	41,888	1966	26.0%	251,384	2005	6.7%	166,422
1889	26.2%	23,880	1928	21.8%	54,495	1967	23.0%	229,543	2006	6.7%	167,046
1890	29.9%	28,664	1929	21.8%	58,612	1968	22.5%	233,686	2007	6.7%	184,225
1891	28.5%	26,849	1930	21.2%	59,258	1969	31.5%	343,757	2008	6.7%	201,561
1892	27.5%	27,351	1931	21.5%	59,555	1970	33.1%	382,807	2009	6.8%	211,005
1893	28.8%	29,903	1932	22.3%	59,318	1971	31.3%	361,783	2010	6.9%	205,423
1894	30.7%	32,280	1933	22.7%	62,611	1972	29.6%	350,940	2011	7.1%	224,396
1895	39.1%	42,967	1934	20.2%	59,094	1973	28.1%	345,898	2012	7.3%	243,655
1896	36.0%	41,022	1935	18.4%	57,338	1974	27.7%	356,443	2013	7.5%	262,470
1897	21.1%	25,308	1936	14.0%	46,447	1975	25.7%	336,064	2014	7.9%	274,692
1898	14.9%	18,481	1937	10.2%	34,480	1976	25.0%	329,108			
1899	16.6%	21,768	1938	8.3%	29,112	1977	23.9%	310,228			
1900	30.4%	39,716	1939	10.8%	41,658	1978	22.5%	297,207			
1901	21.5%	28,717	1940	12.4%	43,522	1979	20.5%	281,526			
1902	17.6%	23,478	1941	10.2%	35,943	1980	19.5%	272,352			
1903	25.5%	35,810	1942	10.2%	36,393	1981	18.7%	261,212			
1904	24.1%	35,111	1943	13.6%	51,223	1982	17.7%	248,806			
1905	23.2%	33,888	1944	17.2%	66,689	1983	16.4%	236,534			
1906	23.7%	37,526	1945	20.4%	80,732	1984	15.3%	229,050			
1907	23.4%	39,575	1946	14.9%	65,316	1985	15.1%	231,422			
1908	25.7%	42,896	1947	15.7%	73,688	1986	13.8%	215,468			
1909	22.8%	38,255	1948	15.9%	75,659	1987	13.1%	211,696			
1910	22.6%	40,074	1949	17.7%	86,111	1988	12.3%	203,159			

Table C2. *Definition of Monetary Aggregates*

	Sweeden
Variable:	Definition:
Mo	Notes and coins in circulation with the non-bank public.
M1	Narrow money, comprises Mo plus deposits that are immediately convertible into currency or used as means of payment, i.e. demand deposits.
M2	M1 plus deposits with a term of maturity of up to two years and deposits redeemable at up to three months' notice.
M3	M3 according to the new definition comprises M2 plus interest-bearing securities with a term to maturity of up to two years. The old (but not the new) definition of M3 also included deposits with agreed-upon terms to maturity of more than two years and deposits redeemable at more than three months' notice. M3 according to the new (but not the old) definition includes shares in money-market funds, money-market instruments and other securities with terms to maturity of up to two years. Since this variable is not used in the econometric estimation the change in its definition will have little effect on the results.

Table C3. *Data Sources*

	Sweden		
Variable	1870-1913	1913-1970	1970-2015
Monetary Aggregates:	Edvinnson, R. and Ögren, A. (2013) Swedish Money Supply 1620-2012, *Historical Monetary and Financial Statistics for Sweden, Volume II,* available at: [Retrieved from].		
GDP	Edvinsson, R. (2016) [Retrieved from].		
Interest Rate	Schularick & Taylor (2012) supplemented by Riksbank data		
Tax Burden	Mitchell International Historical Statistics, Europe 1750- 2000	Stenkula *et al.*, (2014)	OECD
Self-Employment Rate		Edvinsson, R. (2016)	OECD
Unemployment Rate		Edvinsson, R. (2016)	OECD
Total Government Expenditure		Edvinsson, R. (2016)	OECD
Total Welfare Expenditure		Edvinsson, R. (2016)	OECD
Size of Public Sector		Public Employment in Western Nations	OECD
Fraud Incidence		*Punishment and Crime in Scandinavia, 1750–2008* (Von Hofer, 2013) supplemented with *Nordic Criminal Statistics 1950-2015.*	
Wages and Salaries in national Income	Edvinsson R. (2016) available at: [Retrieved from].		

Table C4. *Unit Root Tests*

Sweden 1913-1970						
	At Level			First Difference		
Variable	Intercept	Trend and Intercept	No Trend No Intercept	Intercept	Trend and Intercept	No Trend No Intercept
C/M2	-1.156	-0.618	-0.684	-6.616***	-6.669***	-6.644***
Y/Cap	1.069	-1.816	4.761	-8.106***	-8.406***	-6.166***
R	-0.630	-0.580	0.786	-7.403***	-7.487***	-7.372***
Tax	1.369	-1.866	4.127	-7.402 ***	-7.801***	-6.050***
SELF	5.421	2.959	-3.424	-2.928 **	-4.023**	-2.296***
REG	.638	-2.662	2.882	-8.466***	-8.626***	-7.498***
WAGES	-1.294	-2.582	1.434	-5.796***	-5.744***	-5.721***

Sweden 1970-2015						
	At Level			First Difference		
Variable	Intercept	Trend and Intercept	No Trend No Intercept	Intercept	Trend and Intercept	No Trend No Intercept
C/M2	-2.561	-2.273	-0.731	-7.337***	-7.467***	-7.338***
Y	0.863	-0.709	1.121	-5.630***	-5.661***	-3.476***
R	0.788	-1.005	1.295	1.486	-.905	2.240**
Tax	-0.682	-1.584	-0.77	-5.038***	-4.998***	-4.214***
SELF	-2.45	-2.612	-0.792	-7.108***	-7387***	-7.149***
REG	-2.627*	-1.759	0.23	-5.704***	-6.074***	-5.677***
TOT EXP	-0.595	-2.098	-1.002	-5.130***	-5.235***	-5.047***
FRAUD	-1.474	-1.261	-0.041	-7.326***	-7.408***	-7.403***

Notes: (ADF) test. Null hypothesis: variable has unit root.
The lag length was chosen using the Schwarz Information Criterion.
*, **, *** indicate significance at the 10, 5, and 1 percent level respectively.
Source: Own calculations

Table C5. *Stability Analysis*

	Cointegrating Coefficients Sweeden					
	1913-1970			1970-2015		
Dependent Variable	C	C/M1	C/M1	C/M1	C/M2	C/M2
	1.00	1.00	1.00	1.00	1.00	1.00
Y/capita (real income/capita)	1.96***	-1.251***		1.16**	.851**	
	.24	(.34)		(.65)	(.48)	
Y (real income)			-.441***			1.204***
			(.15)			(.22)
R (interest rate)	-.208***	.233***	0.11***	.411***	.325***	.413***
	(.07)	(.09)	(.001)	(.11)	(.06)	(.02)
TAX 2 (Top Marginal tax Rate)	.471***	2.389**	1.147***	1.18***	3.145**	2.223***
	(.12)	(.07)	(.15)	(.12)	(1.67)	(.15)
REG (public employment)			.54***	.454***	.743***	
			(.02)	(.17)	(.24)	
SELF (self-employment)	1.254*		1.421**	1.787***		.883**
	(.76)		(.63)	(.08)		(.489)
CRIME (fraud incidence)		.42**		.358***		.130**
		(.19)		(.11)		(.07)
SOC (social welfare expenditure)	.45***				3.493*	-1.471***
	(.03)				(2.03)	(.41)
GOV (government expenditure)		-1.751***		.176		
		(.41)		(.18)		
WAGE (Wages & Salaries in Nat Income)		-4.144***	-.655***			
		(1.21)	(.008)			
UE (Unemployment rate)					.724***	
					(0.18)	
Constant	3.648***	-10.126***	14.251***	-7.421***	18.26***	12.51
	(.741)	(2.01)	(3.41)	(1.79)	(3.51)	(11.13)
Observations	58	55	55	50	47	47
Autocorrelation	22.28	33.71	24.01	34.95	54.15	48.94
LM Test						
Lag	1	4	4	1	4	4
LogLiklihood	181.56	220.51	181.04	225.03	391.06	321.614

Appendix D. Detailed Results - United States

Table D1. Shadow Economy Estimates.

(1) Size of the shadow economy as a percentage of GDP

(2) The monetary value of the shadow economy (million USD) in real terms (2009 prices)

Year	(1) % of GDP	(2) USD mn	Year	(1) % of GDP	(2) USD mn	Year	(1) % of GDP	(2) USD mn	Year	(1) % of GDP	(2) USD mn
1870	10.2%	12,330	1908	17.9%	95,078	1946	15.9%	312,707	1984	13.1%	954,240
1871	10.5%	13,295	1909	22.9%	130,689	1947	13.5%	261,176	1985	13.5%	1,026,496
1872	9.7%	13,409	1910	23.1%	133,194	1948	13.2%	267,399	1986	13.0%	1,025,61
1873	7.6%	11,391	1911	26.7%	158,981	1949	8.6%	173,714	1987	14.2%	1,154,17
1874	7.5%	11,451	1912	26.7%	166,190	1950	9.1%	198,242	1988	13.4%	1,132,64
1875	10.5%	15,915	1913	32.5%	210,724	1951	9.4%	222,41	1989	13.3%	1,170,42
1876	10.3%	16,320	1914	36.9%	220,860	1952	7.5%	183,89	1990	13.4%	1,198,19
1877	11.7%	19,410	1915	36.3%	223,271	1953	8.4%	216,292	1991	12.6%	1,125,70
1878	12.4%	21,246	1916	34.8%	243,365	1954	8.4%	214,729	1992	12.0%	1,114,23
1879	10.8%	20,651	1917	35.7%	243,805	1955	9.7%	266,835	1993	11.8%	1,123,18
1880	11.0%	22,694	1918	34.3%	255,119	1956	9.5%	267,037	1994	11.7%	1,161,59
1881	9.8%	22,943	1919	29.2%	219,035	1957	11.0%	313,591	1995	11.7%	1,187,27
1882	10.2%	25,135	1920	24.7%	183,643	1958	12.7%	360,961	1996	12.1%	1,278,294
1883	10.1%	25,403	1921	29.0%	210,399	1959	14.5%	440,154	1997	12.3%	1,359,83
1884	10.2%	25,246	1922	28.1%	214,971	1960	13.2%	409,854	1998	12.5%	1,437,91
1885	6.6%	16,459	1923	21.0%	181,780	1961	14.1%	449,745	1999	12.1%	1,457,33
1886	8.3%	22,410	1924	21.7%	193,620	1962	16.2%	546,396	2000	12.2%	1,529,75
1887	9.5%	27,541	1925	16.1%	147,591	1963	19.3%	679,864	2001	10.6%	1,339,80
1888	9.2%	28,206	1926	15.9%	154,821	1964	20.1%	750,129	2002	7.9%	1,020,83
1889	9.1%	28,581	1927	16.0%	157,527	1965	17.2%	685,031	2003	7.0%	934,609
1890	10.1%	34,702	1928	16.6%	165,045	1966	14.7%	624,89	2004	7.1%	977,363
1891	10.3%	36,050	1929	16.3%	171,863	1967	18.6%	808,942	2005	8.1%	1,146,05
1892	11.8%	43,076	1930	17.7%	170,998	1968	17.8%	814,011	2006	8.6%	1,259,95
1893	12.7%	43,748	1931	15.0%	135,294	1969	19.2%	902,743	2007	8.6%	1,283,46
1894	14.5%	47,596	1932	19.1%	150,619	1970	22.1%	1,042,811	2008	7.1%	1,048,755
1895	15.4%	56,404	1933	18.1%	141,147	1971	20.5%	999,828	2009	5.4%	776,004
1896	16.8%	60,565	1934	21.0%	180,919	1972	21.2%	1,089,327	2010	5.4%	795,496
1897	16.7%	62,664	1935	19.8%	186,391	1973	20.5%	1,111,278	2011	5.5%	822,806
1898	13.7%	57,131	1936	20.8%	220,319	1974	21.4%	1,156,581	2012	5.6%	853,938
1899	14.1%	63,024	1937	18.8%	208,996	1975	19.4%	1,042,553	2013	6.3%	974,37
1900	10.2%	46,583	1938	19.0%	204,324	1976	17.3%	984,33	2014	6.5%	1,031,61
1901	11.1%	53,468	1939	16.6%	193,660	1977	19.3%	1,143,360			
1902	12.0%	60,552	1940	22.7%	287,501	1978	18.0%	1,126,040			
1903	11.7%	61,037	1941	25.8%	384,027	1979	17.7%	1,142,584			
1904	12.6%	63,032	1942	24.3%	430,859	1980	17.7%	1,141,685			
1905	12.2%	68,245	1943	27.4%	567,353	1981	18.0%	1,188,449			
1906	16.0%	93,099	1944	21.4%	480,070	1982	17.6%	1,143,976			
1907	15.4%	92,012	1945	15.8%	350,050	1983	13.4%	910,305			

Table D2. *Definition of Monetary Aggregates*

United States		
Variable	Definition:	Additional remarks:
M0	Currency in circulation refers to the currency stock minus currency held by the monetary authorities. The currency stock refers to the total amount of currency issued in the United States in U.S. dollars, including currency issued by U.S. firms and by the monetary authorities (the Treasury and, after 1914, the Federal Reserve).	This definition of M0 is similar to M1 in the UK (i.e. including deposit accounts). However, the data source allows for the distinction between actual cash in circulation and cash + the amount in deposit accounts.
M1	Currency in circulation outside the vaults of depository financial institutions; traveller's checks issued by nonbank financial institutions; and certain deposits, transferable by cheque, that are held by the nonbank public.	
M2	M1 plus the nonbank public's holdings of certain savings and time deposits at depository institutions and of shares in retail-oriented money market mutual funds. These deposits, although not commonly used as medium of exchange, are highly liquid.	
M3	M2 plus the nonbank public's holdings of large- denomination time deposits at depository financial institutions and of institutionally oriented money market mutual funds.	

Table D3. *Data Sources*

	United States		
Variable:	1870-1913	1913-1970	1970-2015
Monetary aggregates	Anderson, R (2003) "Historical U.S. Currency and Monetary Aggregates Data" Federal Reserve Bank of St. Louis, WP 2003-006 supplemented with FRED data		
GDP	Williamson, S.H (2016) "What Was the U.S. GDP Then?" MeasuringWorth, URL: [Retrieved from]		
Interest Rate	Schularick and Taylor 2012 supplemented by FRED data		
Tax Burden	Mitchell International Historical Statistics, The Americas 1750- 2000	Piketty, Thomas, "Capital in the 21st Century, Harvard University Press", 2014	OECD available at [Retrieved from].
Self-Employment Rate			OECD available at [Retrieved from].
Unemployment Rate Total		NBER C2644	OECD available at [Retrieved from].
Government Expenditure		[Retrieved from].	
Total Welfare Expenditure		[Retrieved from].	
Size of Public Sector		Statistical Abstract of the United States 1878-2012	OECD
Fraud Incidence		*Historical Corrections Statistics in the United States, 1850- 1984* Dept. of Justice available at: [Retrieved from]. supplemented with *United States Crime Rates 1960 – 2015* [Retrieved from].	
Wages and Salaries in national Income	*NBER C1567* supplemented with [Retrieved from].		

Table D4. *Unit Root Tests*

United States 1913-1970						
	At Level			First Difference		
Variable	Intercept	Trend and Intercept	No Trend No Intercept	Intercept	Trend and Intercept	No Trend No Intercept
C/M2	-1.030	-1.148	0.659	-4.495***	-4.474***	-4.513***
Y/Cap	0.089	-1.988	2.696	-5.008***	-4.973***	-4.650***
R	-0.655	-0.590	-0.656	-8.316***	-8.665***	-8.331***
Tax	-2.301	-1.926	0.005	-6.352***	-6.479***	-6.318***
WELFARE	-1.100	-1.183	-1.649*	-5.152***	-5.130***	-4.979***
WAGES	-1.773	-3.078	1.538	-4.833***	-4.750***	-4.754***
FRAUD	-1.454	2.719	0.794	-3.504**	-3.157**	-3.592**

United States 1970-2015						
	At Level			First Difference		
Variable	Intercept	Trend and Intercept	No Trend No Intercept	Intercept	Trend and Intercept	No Trend No Intercept
C/M2	0.297	-1.801	-1.674	-4.223***	-4.320***	-4.084***
Y/Cap	-1.865	-1.398	6.269	-5.570***	-5.628***	-3.877***
R	-0.712	-2.431	-0.665	-8.658***	-9.216***	-8.689***
Tax	-2.951*	-2.918	0.276	-6.000***	-5.937***	-6.050***
WELFARE	-2.358	-2.114	-0.116	-4.877***	-4.979***	-4.898***
SELF	-2.746*	-1.760	-1.137	-5.140***	-5.097***	-4.433***
REG	-2.740*	-1.831	0.432	-4.416***	-4.345***	-4.489***
FRAUD	-1.427	-0.924	-0.254	-4.115***	-4.157***	-4.157***

Notes: Reported above are the T-statistics for the Augmented Dicky-Fuller (ADF) test. Null hypothesis: variable has unit root.
The lag length was chosen using the Schwarz Information Criterion.
*, **, *** indicate significance at the 10, 5, and 1 percent level respectively.
Source: Own calculations

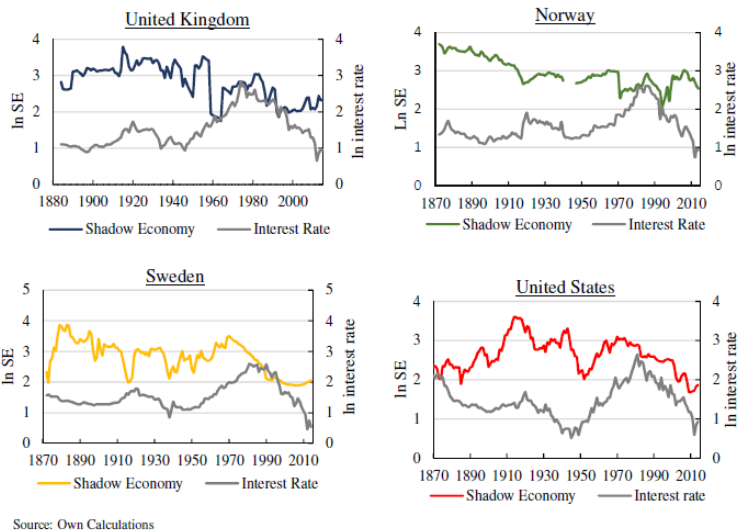
Table D5. *Stability Analysis*

	Cointegrating Coefficients Sweeden					
		1913-1970			1970-2015	
Dependent Variable	C	C/M1	C/M1	C/M1	C/M2	C/M2
	1.00	1.00	1.00	1.00	1.00	1.00
Y/capita (real income/capita)	2.16**	-0.85**		1.14**	1.41**	
	(1.15)	(.44)		(.58)	(.72)	
Y (real income)			-1.441***			2.499***
			(.25)			(.09)
R (interest rate)	-.191***	.443***	0.191***	.321***	.215***	0.387***
	(.07)	(.12)	(.09)	(.07)	(.04)	(.02)
TAX 2 (Top Marginal tax Rate)	.521***	1.589**	2.147***	1.15***	-5.685**	-14.12***
	(.12)	(.07)	(.15)	(.12)	(3.21)	(2.15)
REG (public employment)	.047**			.724**	.523***	
	(.02)			(.17)		
SELF (self-employment)	.883*		1.421**	1.339***		.981**
	(.461)		(.63)	(.11)		(.489)
CRIME (fraud incidence)		.411***		.58**		.511**
		(.13)				(.249)
SOC (social welfare expenditure)	.45***					-1.471***
	(.03)					(.41)
GOV (government expenditure)		-2.251***		.65***		
		(.41)		(.03)		
WAGE (Wages & Salaries in Nat Income)		-1.744***	-3.125***			
		(.54)	(1.02)			
UE (Unemployment rate)					1.24*	
					(0.66)	
Constant	3.52***	9.056***	17.251***	4.12***	11.26***	22.51***
	(1.09)	(2.01)	(3.41)	(.89)	(2.01)	(4.12)
Observations	59	56	56	50	47	47
Autocorrelation LM Test	21.28	31.25	42.12	23.99	30.61	34.94
Log Likelihood	134.064	229.06	315.9	149.45	214.27	237.59
Lags	1	4		1	4	4

Appendix E. Presentation of the results over 1870 to 2015

We show the size and development of the shadow economy of these four countries by comparing the development of the shadow economy over time, with the interest rate, the unemployment rate, and the tax burden.

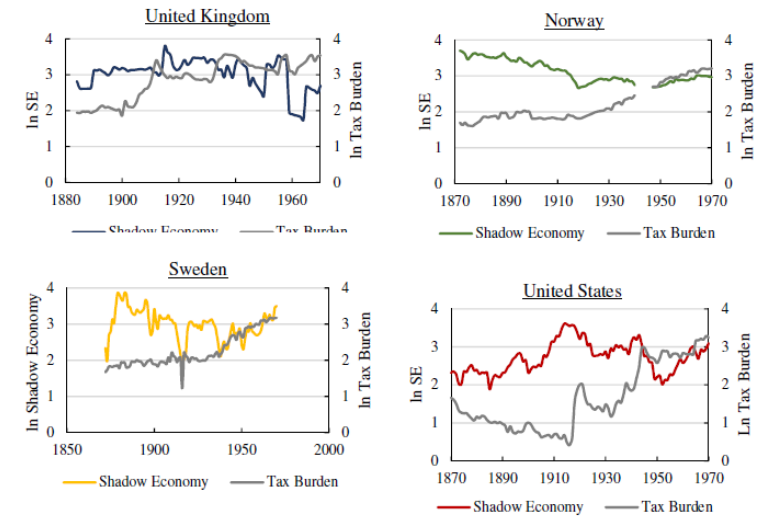
Figure E1 graphs shadow economy estimates as a percentage of GDP and the interest rate. The natural logs of both variables have been taken. In the UK the relationship appears to be positively correlated; An increase in the interest rate leads to an increase in the size of the shadow economy. The same is true in Norway and Sweden and also in the United States after 1950. Prior to 1950 in the United States the variables appear to be negatively correlated; a decrease in the interest rate leading to an increase in shadow economic activity. However, causality is difficult to prove and there may even be reverse causality; monetary policymakers, aware of the growing shadow economy, increase interest rates in an attempt to induce capital flows into the banking system again.



Source: Own Calculations

Figure E1. *Shadow Economies and the Interest Rate 1870-2015*

The main variable of interest in this study is the tax burden and its interaction with the shadow economy. Figure E2 graphs the relationship between the natural log of these two variables from 1870- 1970. The results show a positive correlation of the most part (with the exception of pre-1920s Norway). In the case of the UK the tax burden experiences a sharp increase in 1914, this is followed by a sharp increase in shadow economic activity in the years that follow. In the United States, during period where there was an increase or a decrease in the tax burden, shadow economic activity responded likewise. The same caveats regarding causation and reverse causality apply in this case; is the decreasing tax burden responsible for an decreasing shadow economy or are monetary policymakers reducing the tax rate in an attempt to reduce the size of the shadow economy. In the case of the UK and Sweden the graphs would imply causation since the increase (decrease) in the tax burden occurred before the increase (decrease) in the size of the shadow economy.



Source: Own Calculations

Figure E2. *Shadow Economies and the Tax Burden 1870-1970*

Figure E3 depicts the relationship between the shadow economy and the tax burden during the 1970- 2015 period. The variations in the tax burden are less pronounced however during periods when the burden of taxation increases shadow economic also increases soon after, implying a positive correlation between the two variables. The exception is Sweden where there seems to be a negative relationship.

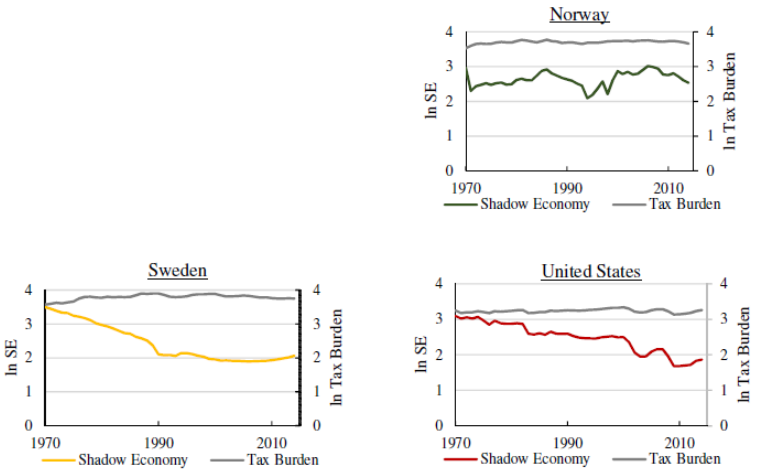


Figure E3. *Shadow Economies and the Tax Burden 1970-2015*

Figure E4 graphs the relationship between the rate of unemployment and the size of the shadow economy. Unemployment is hypothesised to have a positive effect on the size of the shadow economy. In the United Kingdom, Sweden and the United States there apprears to be a positive correlation between the two variables; an increase in unemployment leads to an increase in shadow economic activity and vice versa. It is difficult to infer a relationship fin the case of Norway due to gaps in the data.

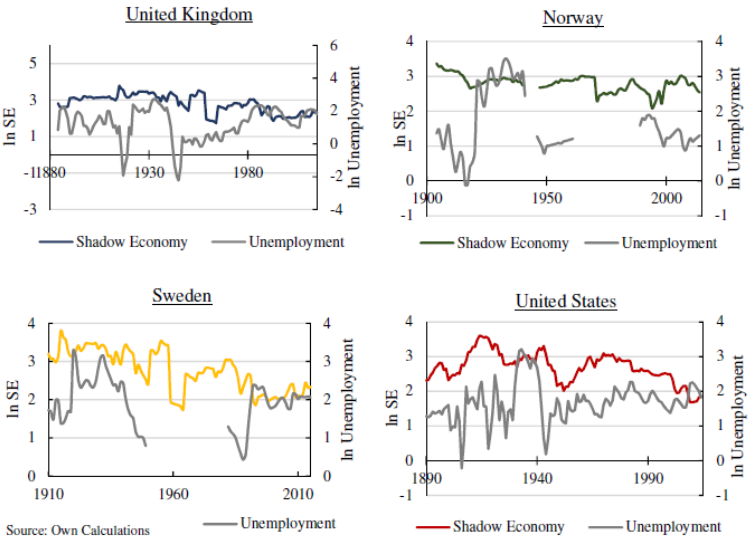


Figure E4. *The Shadow Economy and Unemployment 1880-2015*

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Grey Matters: Charting the Development of the Shadow Economy

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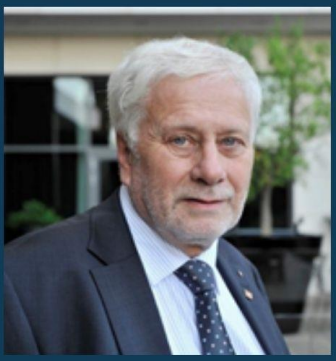

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